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CONTENTS

Editorial	41
Metal Finishing Research at Battelle Institute	42
Some Notes on Synthetic Detergents	48
By A. Mankowich	
Chemical Polishing	50
Barrel Tumbling Practice on Yale Hardware	51
By J. E. Charleson	
Hard Nickel Plating	53
By M. H. Orbaugh	
The Deposition of Copper from Phosphoric Acid Solutions	56
By C. B. F. Young and Fred I. Nobel	
The Fatigue Limit of Chrome Plated Aircraft Steels ..	60
Safe Use of Perchloric-Acetic Electropolishing Baths ..	62
By Dr. Pierre A. Jacquet	
Shop Problems	70
Patents	72
Engineering Data Sheet	74
Recent Developments	75
Business Items	82
News from Detroit	88
Associations and Societies	89
Manufacturers' Literature	92
News from California	95
A Letter to the Ladies	97
Obituary	97
Letters to the Editor	99

COMING SOON

How to save money in the plating department through control of the water used.

Practical yellow gold plating, including color control and operating techniques.

A discussion of a new method for plating on aluminum using a special alloy pre-plate treatment.

Commercial automatic installation for electropolishing refrigerator shelves of stainless steel.

Automatic plating of copper, nickel, brass, and chrome on a single plating machine.

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cobalt nickel
plating processes?"*

Richard E. Waite

Field Representative

H-VW-M Rochester Office

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METAL FINISHING, November, 1949

Guaranteed Plating

While looking over the various exhibits of builders hardware at the recent New York exposition of the National Contract Hardware Association, we ran across one item that struck us as being pertinent and quite important to the plating industry. One of the exhibiting firms showing a general line of beautifully finished hardware was extolling the durability of their finishes to the extent that a written agreement would be furnished with their hardware guaranteeing the finish for a period of ten years. Several reasonable modifying conditions were, of course, stated in the guarantee.

The effectiveness and value of this particular guarantee are not pertinent to the present discussion—the important issue is the recognition by this firm that here was a valuable selling point—durability of the finish on an item where the finish is all important to satisfactory performance. It is a point which could well stand imitation on a wide range of plated goods, and one which, if intelligently and carefully applied, would provide a tremendous boost for the electroplating industry generally.

While a ten year guarantee might be excessive for some items, any such guarantee should cover insofar as possible at least the average life expectancy of the particular item to which it applies. In other words, failure of any item to give complete satisfaction because of an inferior plating job would be at a minimum. Usually all that would be required to make guaranteed plating feasible on a great variety of articles is an increase in the plating thickness, and with today's high speed plating processes this problem can no longer be considered insurmountable.

In a competitive field, and never let us forget that plated finishes are very definitely in such a competitive position, it is not only the "purchase" appearance, but the permanence of the finish that is important to complete customer satisfaction and broadened applications. Guaranteed plating would be a big step in the right direction.

W. A. Raymond

EDITOR

Metal Finishing Research at Battelle Institute



The main laboratory buildings of Battelle Institute. Another three-story structure is under construction to the left of the center building. The electrochemical engineering laboratories are located in the right rear structure. A large suburban agricultural laboratory and four other outlying laboratories and warehouse buildings bring the total floor space of the Institute to approximately 500,000 square feet.

ONE OF the foremost sources of metal-finishing developments in the country is Battelle Institute, an endowed research foundation located in Columbus, Ohio. In the trade, this laboratory is well known for its pioneering work on alloy plating, electropolishing, and for various processes of bright plating, electroforming, and decorative finishing. Among technologists in the field, Battelle is additionally known for its numerous contributions to understanding of the fundamental principles of electrolytes, surface phenomenon, corrosion, and other phases of electrochemistry.

The pictures on these pages give an impression of the extent and type of facilities at Battelle for metal-finishing research. Under the Institute's research-for-industry plan, all of these facilities, plus the related equipment in its numerous other laboratories, shops, and service divisions, and the technical know-how of its 1,300 staff members are available for solving the research problems of individual companies.

Battelle Memorial Institute was founded by *Gordon Battelle*, son of a pioneer Ohio industrialist, whose will provided for the building and endowment of a non-profit Institute "for the purpose of education . . . the encouragement of creative research . . . and the making of discoveries and inventions" for industry. The founder died in 1923, and the Institute first opened its doors in 1929. An endowment provides funds for buildings and permanent equipment, as well as for an extensive program of fundamental research and of research education. Since its founding, Battelle has served more than a thousand sponsors by developing new materials, products and processes, and improving old ones by reducing costs, rectifying the causes of manufacturing failures, making technical-economic studies, and in many other ways assisting industry.

How a Research Project Is Handled

The best way to get an impression of how a research project for an industrial sponsor is handled at Battelle is to take an imaginative case and follow it through from start to finish:

The John Doe Corporation, manufacturers of household appliances, wishes to develop an improved method of bright-plating metal X on aluminum. The object is an attractive, corrosion and abrasion-resistant finish for an appliance part. The corporation's representatives discuss the problem with Battelle technologists and executives, who appraise the chances for success. It is decided that the project has promise and Battelle ascertains that the line of endeavor does not conflict with prior commitments. The best rate of effort and the cost of the proposed research are estimated and a contract drawn up and signed.

Since the problem falls directly into the scope of activity of the Electrochemical Engineering Division, that group is given major responsibility for the research. The divisional supervisor assigns an engineer and technicians to conduct the work. The engineer begins his study with a visit to the plant of the John Doe Corporation. Here he obtains the case history of the company's efforts, if any, to bright-plate metal X on aluminum. He talks with officials, technical men, and workmen. When he leaves, he is thoroughly acquainted with the manufacturing process for the appliance part, technical limitations, and economic considerations.

Back at Battelle, a patent and literature survey is made and roundtable discussions are held to formulate a plan of attack. It is agreed that a duplex plate will be required and the literature study suggests that there may be hope of success by depositing the first plate

from a neutral bath after a suitable pre-dip for cleansing and oxide removal. The laboratory work begins.

There are several ideas offered regarding the formulation of the cleaning bath and the first plating bath. These are tried, and after a short period of experimentation a satisfactory cleaning bath is devised. Also, provisions are made in the first plating bath for removing the light oxide film formed after the cleaning dip. Sample plates are produced. At this point, the first serious snag is encountered—the plate turns out to be porous. How can the porosity be eliminated?

The metallographic laboratory is called upon for metallographic analysis. The physics laboratory is given specimens for X-ray and electron diffraction studies, then there are more round-table discussions. A possible solution to the porosity appears to be in the use of a suitable organic addition agent. Battelle organic chemists go to work. Various addition agents are developed and evaluated. Finally, a bath is formulated which gives a dense, non-porous plate. Metallographic examination, as well as mechanical tests made in the mechanical testing laboratories, establish that the plate is well-bonded and suitable as a surface to receive the follow-up bright-plate.

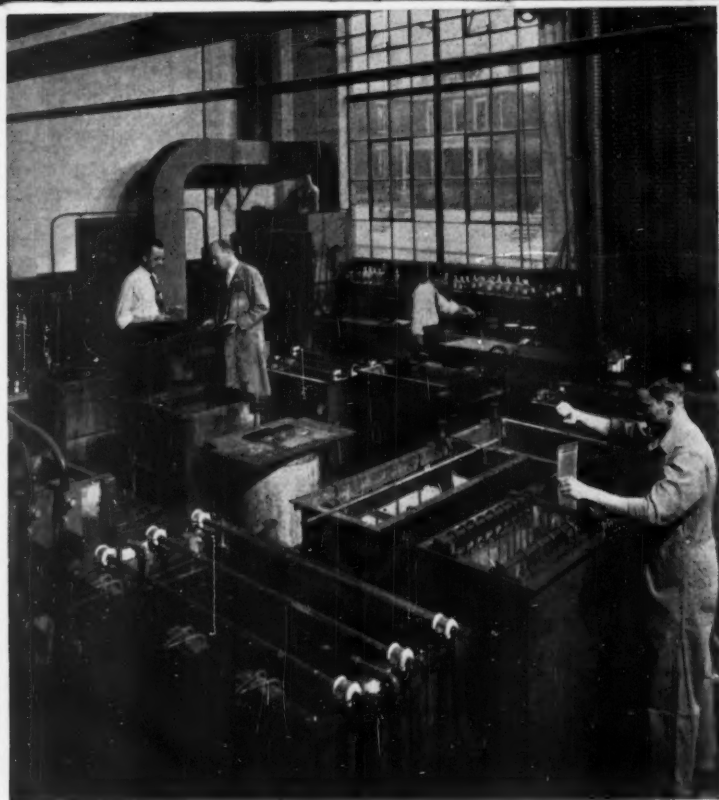
As the work proceeds, monthly progress reports are made to the sponsor and there are meetings between the sponsor representatives and Battelle men. After the first good plates are obtained, it is decided that



Dr. Charles L. Faust has active direction of Battelle research in electroplating, electropolishing, and electrochemical engineering. He is the inventor of processes for electropolishing—holds more than a dozen patents on it and on electroplating and chemical processing; is a national vice-president of The Electrochemical Society and member of its Publication Committee and Board of Directors; and currently serves as an associate editor of *Plating*, publication of the American Electroplater's Society.

Most research studies at Battelle begin in the library. To prevent lost motion and unnecessary expense, the research man must know what has been done on the problem by other investigators, what are the likely leads, what is the status of the "prior art." This is a section of a reading room in the Battelle library. In addition to its more than 15,000 volumes and complete patent file, the library subscribes to 700 current technical journals.





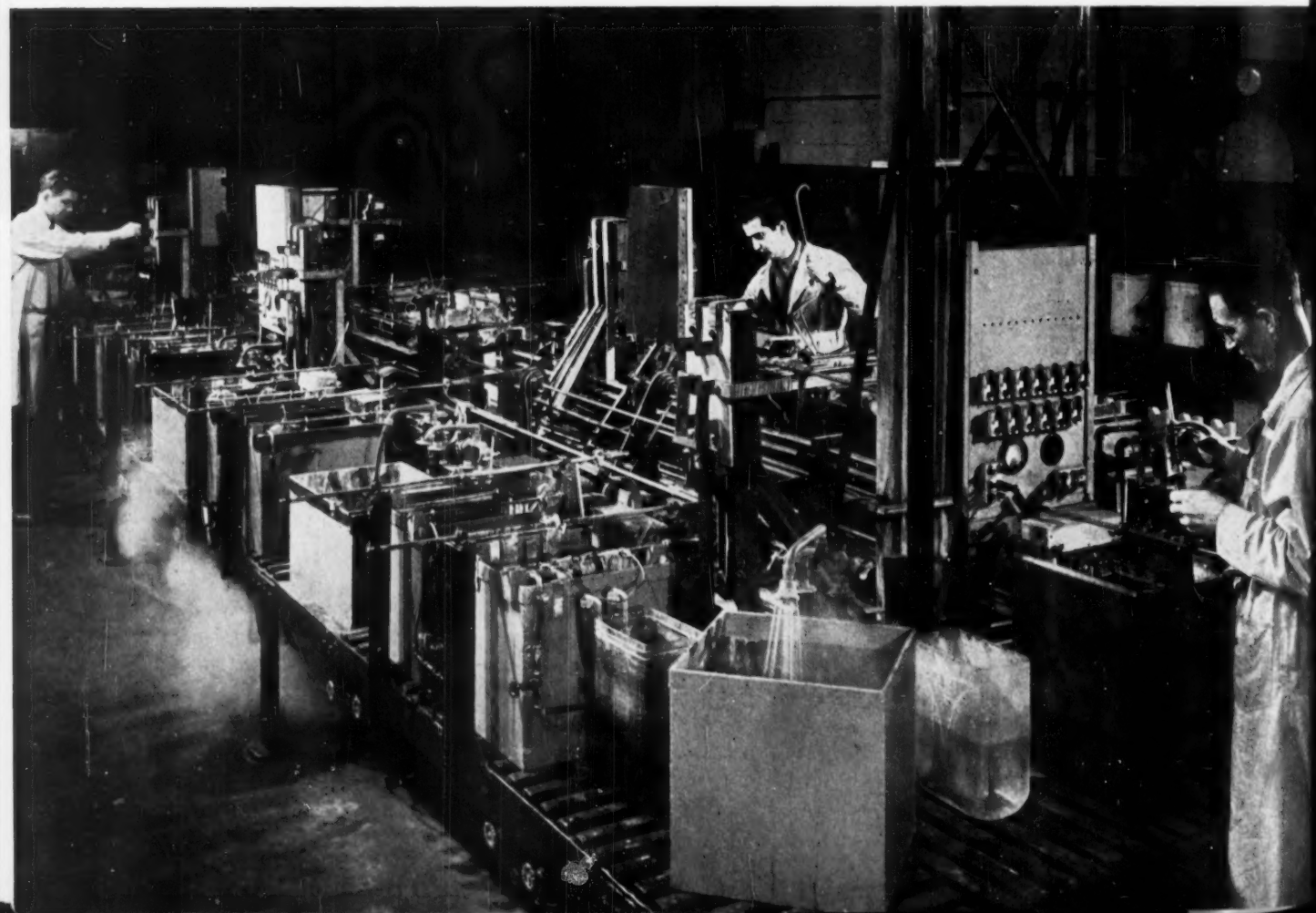
This plating unit is a focal point of much of the Institute's research in metal finishing. Designed for flexibility, it permits the setting up of complete cleaning, plating, and electropolishing cycles on a pilot-plant basis. Work on several different developments may be in progress on the unit simultaneously.

Tanks of this size makes possible the evaluation of plating processes on a pilot-plant scale. These tanks are adaptable to plating or electropolishing of numerous metals.

the sponsor should have patent protection and the Battelle patent department, at the sponsor's request, files patent applications to cover the work done so far.

The research continues, with attention being given to development of a bath and process to put the second layer of metal X on actual appliance parts. Several bright-plating baths are identified which give excellent results. Various physical tests establish that the plate meets the sponsor's specifications. An economic appraisal made by the Institute's engineering-economics experts indicates that there are no economic implications tied up with supply of materials that would make adoption of the process risky.

The sponsor decides to prepare for adoption of the process in his plant and asks Battelle to go ahead with pilot-plant development. The work at the Institute moves from the small individual laboratories to a pilot-plant area. During the design of the pilot-plant, mechanical and production engineering problems are apparent. Battelle's production and mechanical engineering experts work along with its electrochemical engineers in solving these. Finally, the process is operating smoothly on large scale, and the John Doe Corporation begins adapting its production lines to bright-plate metal X on aluminum appliance parts. All the information and discoveries resulting from the project are outright property of the sponsor and all patents resulting therefrom are assigned to him.



Research Produces Practical Results

CHEMICAL POLISHING

One of Battelle's newer and highly important metal finishing developments is a chemical polishing process. This is a simple immersion process, suitable for producing a polished, highly-reflective surface on metals.

Chemical polishing requires no electrical current. The cleaned work is merely immersed into the bath for a pre-determined time, rinsed, and dried. A bright, reflective surface is imparted to the work. No etching of the surface occurs regardless of the time of immersion. Thick sheet has been repeatedly polished down to foil with no damage to the finish. It can be used as a pre-treatment prior to plating the part with another metal.

Chemical polishing is too new to have allowed for discovery of all its potential uses and limitations. It is probable that its uses will be determined somewhat by the physical characteristics of the product involved as well as by the nature of the market in which the product is sold. In one case—that of a luggage lock manufacturer—chemical polishing has eliminated five buffing operations. This has resulted in a savings of sixty-five dollars per 1,000 locks and hasps.

Chemical polishing baths are based on theories regarding the preferential removal of metal that were developed during Battelle work on electro-polishing. Their chief constituents are phosphoric, nitric, and acetic acids. They operate at temperatures from 70 to 200 degrees Fahrenheit. Brass, copper, nickel silver, nickel and monel metal may be successfully polished. The process is particularly useful for polishing articles of intricate shape and small size which cannot be readily and economically polished by other known methods.

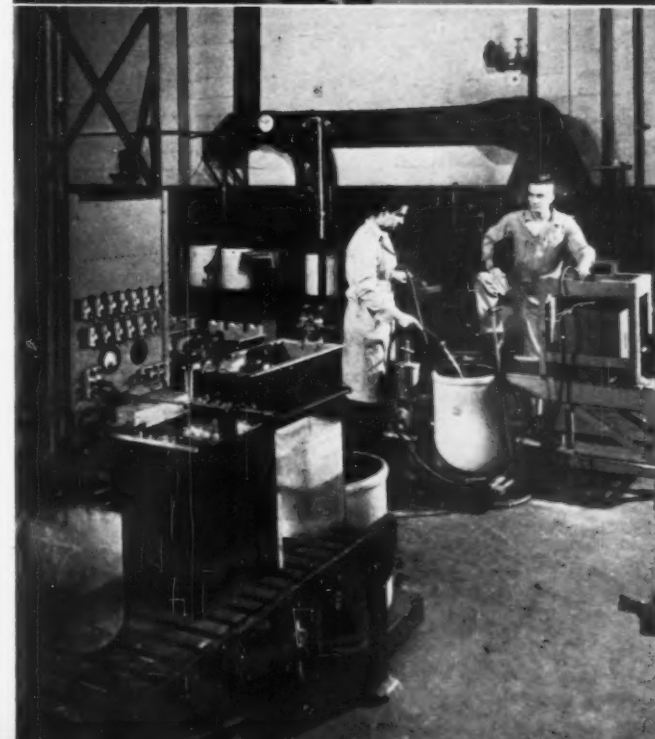
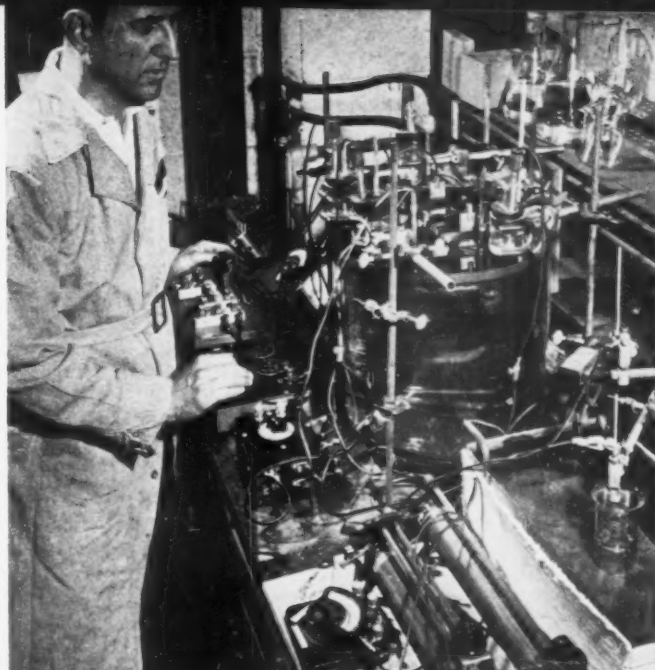
Some of the products that have been finished or prefinished by chemical polishing techniques include picture frames, tableware, luggage locks and hasps, brass plates and rings, brass plumbing fixtures, brass flashlight cases, and brass fireplace screen frames. Other items which have been treated by this process to an acceptable appearance include monel tubing and spinings, nickel silver clips used in the dental industry, brass screws, brass compacts, safety pins, nickel laundry tags, pencil ferrules, and brass license plate frames.

In addition to this type of development work, the Institute also carries on an extensive program in fundamental research, and its staff members are usually prominent in the technical sessions of the various scientific societies, and have contributed many informative papers and articles to the technical publications in this country.

(Top) Typical equipment for determining static and dynamic electrode potentials, knowledge of which is particularly important in studies of corrosion, alloy plating, electropolishing, electrowinning, electroreduction or oxidation of organic chemicals, and battery development.

(Center) Minute quantities of impurities in solutions and chemicals for plating metals are identified by spectrographic analysis. Chemical analysis at the Institute is handled by a central analytical laboratory.

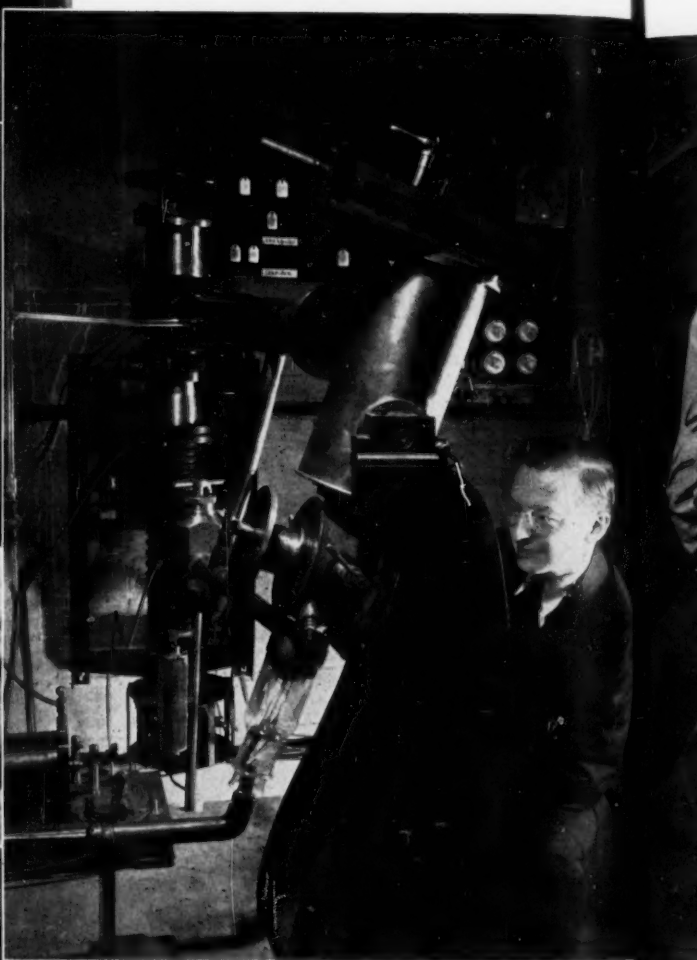
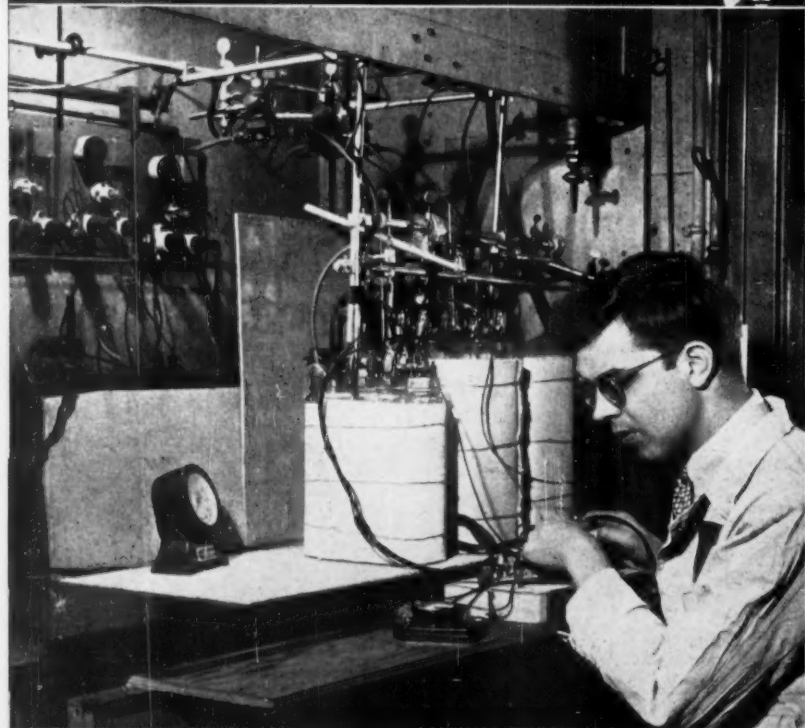
(Bottom) A section of the Institute's electrochemical engineering pilot plant. In the background are facilities for work requiring special ventilation. In the left foreground may be seen a current control panel.



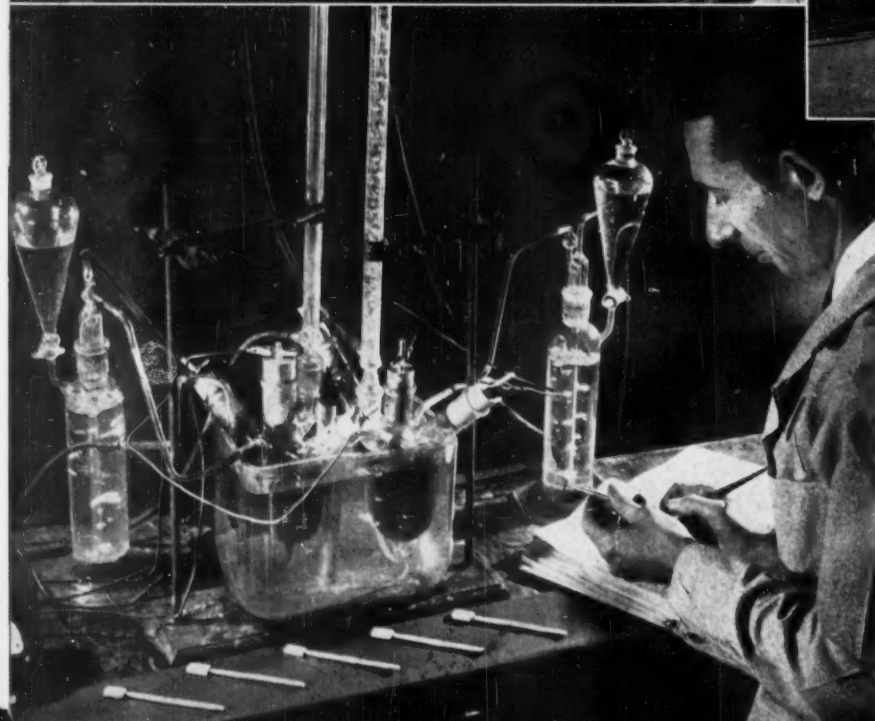


(Top, left) With this laboratory setup the entire surface of a specimen can be uniformly plated "without rack marks." The trick is to plate part of the surface at a time, thus covering up the contact points. Ingenious devices are used to hold specimens.

(Center, left) Battelle has been a pioneer in the development of alloy plating. This is an apparatus used to establish optimum conditions for industrial adaptation of alloy-plating procedures. The plating baths have automatic temperature-control and water-level mechanisms.



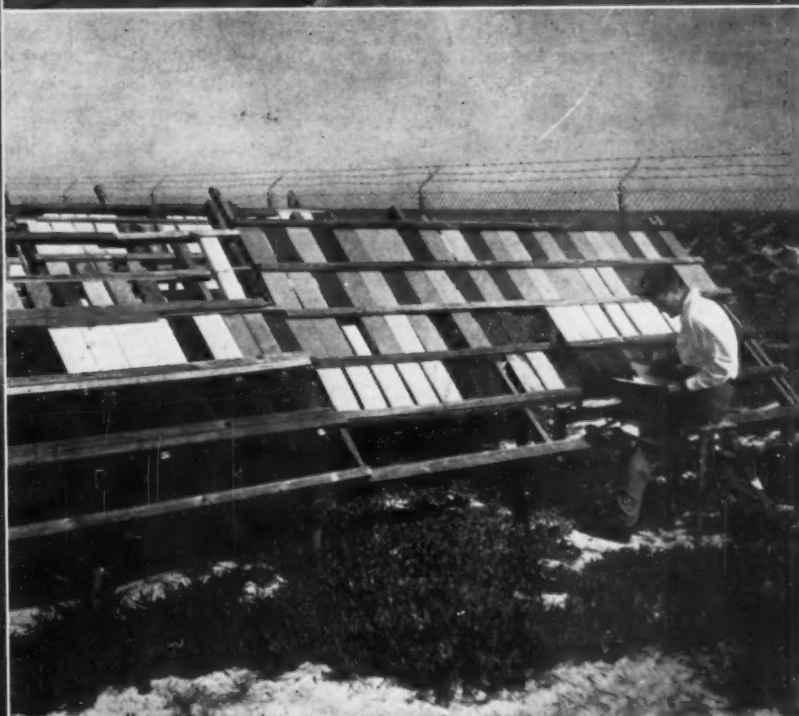
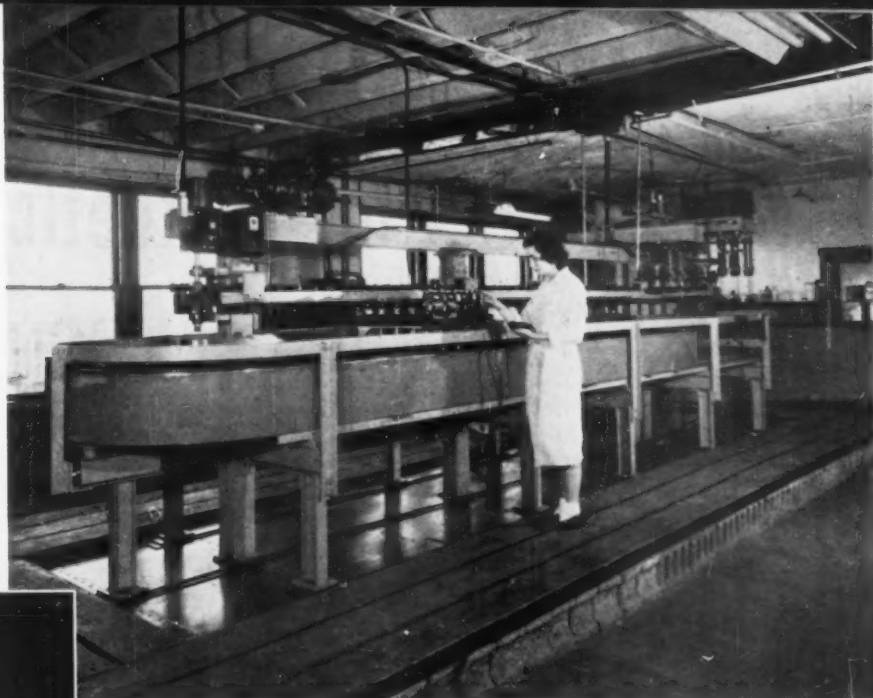
(Above) The electron-diffraction camera is used by Battelle physicists to investigate surface phenomena. This tool aids in the understanding of corrosion mechanisms and characteristics of metal finishes.



(Bottom, left) Some metals that cannot be plated in water solutions are depositable in organic electrolytes. Battelle recognizes this new field and is already at work exploring it. This is special equipment used in plating from organic electrolytes.

(Top, right) A fully automatic machine developed and built at Battelle for electroforming pen caps.

(Center, right) Battelle has its own research station in Florida for the atmospheric and immersion testing of finishes under severe natural corrosive conditions. Atmospheric exposure is also conducted at Columbus. The Florida research station is located at Ormond Beach, Florida.



(Above) When metallographic information is required, Battelle's electrochemical engineers call upon the metallographic laboratory. This laboratory provides expert metallographic analysis. Sometimes the structure of electroplates is critically influenced by the composition and structure of the base metal. In these cases Battelle metallurgists and electrochemists may work as a team.

(Bottom, right) When the engineer working on a problem in electroplating needs a special-built piece of equipment or gadget, he does not have to scour the country to find someone to make it. A drawing and set of specifications routed through the Institute's machine shops will produce the new contrivance post-haste. Skilled machinists also fashion test specimens, lend assistance on special surface studies.



Some Notes on Synthetic Detergents

By A. Mankowich, *Darlington, Maryland.*

THE tremendous growth and established position of the synthetic detergent industry were indicated at the recent meeting of the Association of American Soap and Glycerin Producers. Figures presented there showed an increase in synthetic detergent sales from 69,000,000 pounds in the first quarter of 1948 to 120,000,000 pounds in the last quarter.¹ Consumers of this material included laundries, textile processors, packagers of household soaps and scouring powders, manufacturers of metal cleaning compounds, etc. The plating industry is interested in synthetic detergents chiefly because of their use in cleaning compositions, in which they replace, or are used in conjunction with, soaps to increase detergency, wetting power, emulsification and rinsability.

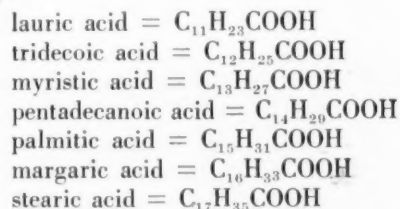
Definitions

Synthetic detergents, or synthetic organic detergents as they are more properly called, belong to a class of chemical compounds termed surface-active. Soap is the most common member of this class. The most simple definition of a surface-active material is that it has the ability to reduce the surface tension of a liquid to which it is added. A more technical definition is that a surface-active material is one that undergoes positive adsorption at the surface of a liquid (or at the boundary between two non-miscible liquids) with consequent reduction in surface tension (or interfacial tension between two liquid phases). Surface tension may be described as the force which produces round drops of liquids. It is due to unbalanced molecular forces acting in the surface layer of a liquid. In addition to decreased surface tension, surface-activity is manifested by one or more of the following properties: penetration, emulsification, dispersion, spreading, detergency, wetting, and foaming.

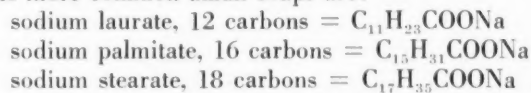
Soap, A Common Surface-Active Material

A brief examination of the constitution and molecular structure of soap reveals points of similarity with synthetic detergents and aids in the understanding of the latter. As commonly used, the term "soap" refers chemically to an alkali (sodium or potassium) salt of a higher fatty acid, or, more exactly, to a mixture of the alkali salts of several fatty acids; for example, sodium laurate and/or sodium palmitate. Fatty acids ("higher") occur in animal and vegetable oils and fats combined with glycerin in the form of compounds called glycerides. In the manufacture of soap, the oils and fats are treated (saponified) with caustic soda to produce the sodium salts of the fatty acids present (soap) and glycerin. Fatty acids occur in series, the members of which differ from each other by increasing

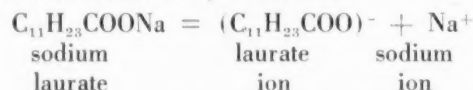
molecular weight. Thus, consecutive members of the so-called saturated fatty acid series differ from each other by one carbon and two hydrogen atoms; for example,



It has been found that fatty acids containing less than 12 carbon atoms in the molecule form soaps which have limited surface-active properties; and, if the soap is formed from a fatty acid with more than 18 carbon atoms, it is of limited solubility in water. Thus, the more common alkali soaps are:



In common with many chemical compounds, alkali soaps are electrolytes and, when dissolved in water, they dissociate into ions, as follows:



Thus, the products of the ionization of sodium laurate soap are positive sodium cations and negative laurate group anions. It is obvious that the surface-active characteristics of this soap solution are due primarily to the anionic laurate group and not to the sodium cations, which occur with no surface-activity in many sodium salt solutions (it is recognized, of course, that the immediate source of surface-activity of soaps is the colloidal, hydrated soap micelles or groups of oriented soap molecules). Soap, therefore, is called an anionic surface-active agent, because its surface-active ability arises in the anionic group of its molecule.

A characteristic of alkali soaps is their behavior in hard water. The hardness of water is due to its calcium and magnesium salts content. The calcium and magnesium salts of the fatty acids are insoluble. Thus, on dissolving an alkali soap in hard water, precipitates of the calcium and magnesium salts of the fatty acids are formed with resulting loss in detergent material. In addition, the calcium and magnesium soaps are difficult to rinse from textiles being laundered or metal being prepared for plating.

Types of Surface-Active Materials

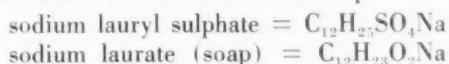
In the discussion of soap, it was stated that alkali soap is an anionic detergent because its surface-activity arises in the anionic group of its molecule. Similarly,

if the surface-activity of a material is due to its cationic group, it is called a cationic agent. If a surface-active material does not ionize, it is called a non-ionic agent. Thus, a synthetic detergent may be classed as anionic, cationic or non-ionic.

Anionic Synthetic Detergents

Anionic synthetic detergents are the type most frequently used in cleaning compositions. These materials are stable to hard water; that is, they form soluble salts with the calcium and magnesium components of hard water. By contrast, alkali soaps react with hard water to precipitate insoluble, difficultly-rinsable calcium and magnesium soaps. Most anionic synthetic detergents are stable to acid and alkalis. Alkali soaps are decomposed by mineral acids at pH values of approximately 8.5 with formation of fatty acids or acid soaps. A rapid qualitative test, subject to confirmation by other tests, for distinguishing between an alkali soap and a synthetic detergent is based on this fact. Thus, the aqueous solution of the metal cleaning composition is acidified with mineral acid. If the solution is still capable of producing a foam when agitated, it contains a synthetic detergent. Loss of foaming ability on acidification indicates that soap was present in the cleaning composition. It is well to remember that the anionic detergent, di-octyl-sodium sulpho-succinate (Aerosol OT), is decomposed in alkaline solution, and is not suitable for use in compounding alkaline cleaners. Anionic detergents are usually stable at elevated temperatures, while alkali soaps tend to lose detergent ability at higher temperatures due to decomposition of the colloidal soap micelles, or groups of soap molecules. Anionic synthetic detergents are compatible and can be used with alkali soaps and/or non-ionic agents, but cannot be used with cationic agents.

Anionic detergents can be subdivided into several groups. One of the important groups consists of fatty alcohol sulphates or alkyl sulphates. Sodium lauryl sulphate, known to many as Irium, is an example of this type. It is interesting to note the structural similarity of this material to an alkali soap:



Another important sub-group of the anionic detergents is the alkyl and alkyl-aryl sulphonate type, a familiar example of the latter being Nacconol NR.

If the structure of an anionic synthetic detergent is examined further, it will be seen that its anionic group consists substantially of a long hydrocarbon chain which possesses oil-soluble characteristics (called hydrophobic) and a water-soluble (called hydrophilic) cationic group. The properties of a detergent are then considered to be the resultant of the hydrophobic and hydrophilic characteristics.

Cationic Synthetic Detergents

Cationic detergents are ones in which the surface-activity arises in the cationic group of the molecule, the anionic group in this type of compound consisting of such radicals as chloride, bromide or iodide ions.

These materials are generally poor detergents. They are unsuitable for use in alkaline metal cleaners, being decomposed by alkalis. Cationic agents are stable in acid and in hard water. They can be used with non-ionic agents, but are not compatible, and cannot be used, with anionic detergents including soap.

Non-Ionic Synthetic Detergents

This class of synthetic detergent does not ionize. It contains hydrophobic and hydrophilic groups in its molecule, surface-activity being due to the resultant of the properties of these groups. A large sub-division of this class includes the fatty acid partial esters of polyhydric alcohols (Spans and Tweens). Another sub-group consists of polymerized ethylene oxide condensation products (Igepal CA). The alkyl aryl polyether alcohols (Triton N-100 and Triton N-155) are another type of non-ionic material. Non-ionic synthetic detergents are stable in hard water and acid solutions. Some types are completely stable in alkaline solution, while other types (esters) are decomposed and, hence, not suitable for use in alkaline metal cleaning compositions. These synthetic detergents are compatible, and can be used, with either anionic or cationic materials. An important characteristic of non-ionic agents is that they usually exhibit inverse solubility; that is, they become less soluble with increase in temperature.

Additional Properties of Synthetic Detergents

A relatively small concentration of surface-active material will produce the maximum reduction in the surface tension of water of which the material is capable. Beyond this concentration there is practically no further depression of surface tension. Thus, a certain anionic synthetic detergent shows the following values (expressed in dynes per centimeter) with change of concentration in distilled water, measurements being made at 25°C:

CONCENTRATION—%	SURFACE TENSION
zero—distilled water	72.0
0.03125	47.9
0.0625	43.8
0.125	38.5
0.25	37.7
0.50	37.4

This information has been supplemented by the establishment of several closely-related facts.² Every synthetic detergent has a narrow, low, concentration range in which there is a considerable increase in all manifestations of surface-activity, such as detergency, surface tension, formation of colloidal micelles, etc. Increase of concentration above the upper limit of the range results in no further increase in surface-active properties. In fact, some properties may show a decrease as concentration of detergent is increased above the upper limit. For sodium lauryl sulphate, the critical concentration range is approximately 0.18-0.25%.

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1. "Oil, Paint and Drug Reporter," January 31, 1949.
2. Preston, "Journal Physical and Colloid Chemistry," Jan. 1948.



A selection of chemically polished brass items.

Chemical Polishing

METAL products can be given a bright, reflective surface without mechanical or electrical operations by a new process recently developed by *Battelle Institute*.

The product to be finished is merely dipped into a chemical solution. When withdrawn a few minutes later, it is polished to a high mirror-like luster.

The chief advantage of the process in production is its simplicity. Items of intricate form can be quickly polished by dip treatment. The surface obtained may serve as the final finished surface or as a base for subsequent plating. In practice, it has been found that chemical polishing may eliminate from one to four or five production steps in the finishing of a metallic product.

Chemical polishing is too new to have permitted discovery of all its potential uses and its limitations. However, it has been used commercially on several products with success. In the case of a luggage lock manufacturer, the process has eliminated five buffing operations in finishing locks and hasps. A savings of about 65 dollars per 1,000 locks and hasps has resulted.

Metals that can be chemically polished successfully include brass, copper, nickel-silver, Monel, nickel, and aluminum. The action in each case is a true polishing action, and the reflective surface obtained is in the polished base metal—not a deposited coating of a different metal.

The need for a simple immersion process for producing a reflective surface has been recognized for some time. Many metal stampings are of such intricate shape

or such a size that they are not only difficult, but often impossible to polish by wheels. The so-called "electropolishing" process may be used to polish some of these stampings, but it cannot be adapted readily to many articles. Others do not require the quality of luster obtained by electropolishing. Other methods of polishing intricate parts, such as tumbling and bright dipping, are not always successful because of scratching or etching. Chemical polishing makes it possible to finish intricate shapes with ease and without etching or other damage to the surface.

Since no electrical current is used in the process, chemical polishing offers great flexibility in the production line. Depending on the size and shape, the parts may be suspended from wires or supported in baskets. With some articles the polishing solution may possibly be used in revolving barrels. Where it is desired to move the work on a conveyor belt, spraying of the work with the solution is another possibility.

Chemical polishing baths are mixtures of acids, the basic ones being phosphoric, nitric, and acetic acids. They operate at temperatures from room temperature to 200 degrees Fahrenheit. At the lower temperature, action of the bath is slower, and longer immersion time is required. Immersion periods vary from 10 seconds to 10 minutes, depending on the initial finish of the surface being treated, the final finish required, and the operating temperature of the bath.

Following the polishing dip, the work is rinsed and dried. If it is desired to plate over the chemically polished surface, this may be done without further treatment of the surface.

The process has been used on picture frames to prepare the surface for subsequent nickel and gold plating. Brass plates assembled with cadmium-plated screws have been chemically polished to produce a surface suitable for subsequent copper and nickel plating. Brass rings, which are normally bright dipped and tumbled prior to receiving a flash gold plate, can be chemically polished in a basket to obtain a satisfactory finish in 90 seconds. Literally hundreds of rings may be pol-

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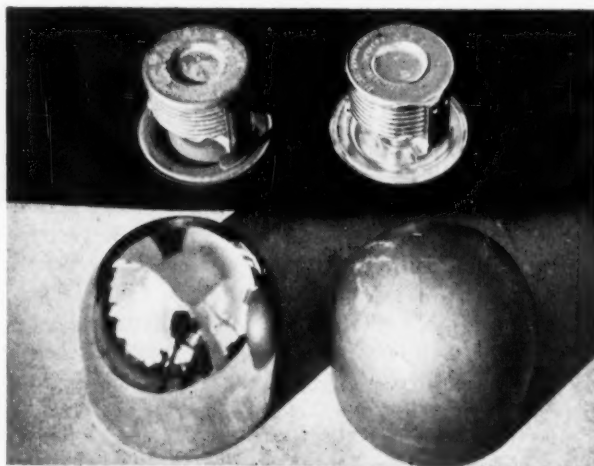


Fig. 1—The automobile thermostat on the right (above) has been dipped into a chemical polishing bath developed by chemists at Battelle Institute, Columbus, Ohio. The thermostat on the left has not been polished. The polished inverted brass cup (left below) reflects its background and surroundings, in contrast to the general lack of reflectivity of the unpolished cup.

Barrel Tumbling Practice on Yale Hardware

By J. E. Charleson, Chief Engineer of Plating and Finishing, Stamford Division, the Yale & Towne Mfg. Co.

Brass and bronze castings are rolled wet in unlined barrels with sand and zinc slugs, to smooth rough surfaces, and then undergo dry tumbling to scour. Many machined parts are deburred by tumbling.—ED.

MILLIONS of hardware parts produced by Yale & Towne Mfg. Co. at its Stamford, Conn. plant undergo tumbling operations, both to smoothen the surface and, in the case of machined parts, to remove burrs. Wheel polishing and buffing are not eliminated, as a rule, especially for plated or bright parts, but such work is much reduced by bulk handling in barrels.

Much of the tumbling work is done on small brass and bronze sand castings that are produced in the company's own foundry, where efforts are made to provide as good an as-cast finish as is obtainable in sand molds, and by subsequent blasting in conventional equipment. Before tumbling, some castings require localized grinding at partings or where unusual roughness occurs, but this is not commonly needed.

Initial tumbling of brass and bronze castings is done in unlined steel barrels about 36 in. in diameter and having conical ends. Such barrels, Fig. 1, are commonly run about half full. The charge includes, as

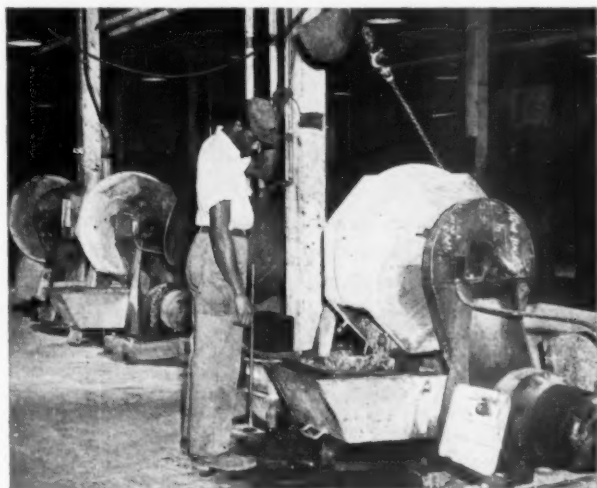


Fig. 1—Emptying a load of bronze sand castings that have been tumbled wet in an unlined steel barrel with zinc alloy eggshape slugs and sand to prepare surfaces for subsequent scouring. Back of the operator is one of the inclined open barrels in which castings are dried in sawdust after washing and separating from slugs.

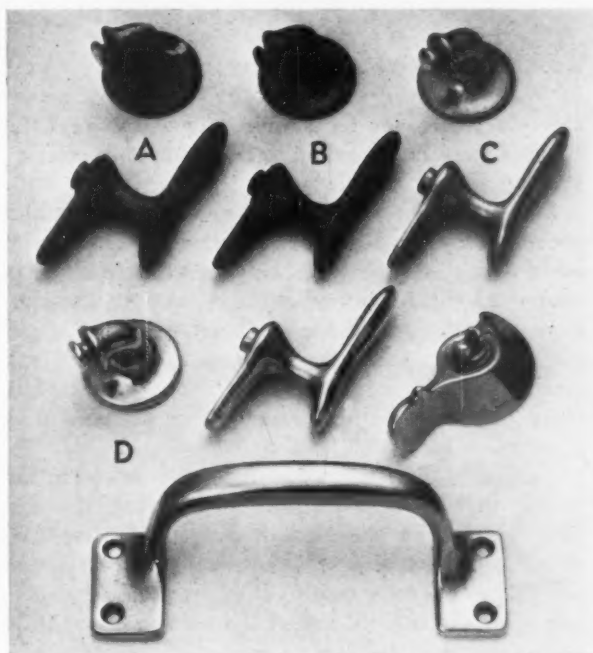


Fig. 2—Typical bronze sand castings for hardware applications as they appear (A) as cast, (B) as smoothed after wet tumbling with zinc slugs and sand, (C) after bright scouring in a dry barrel with vegetable ivory chips and powdered silica and (D) after final dry tumbling in vegetable ivory chips mixed with soft scrap leather and powdered nickel rouge.

a rule, three volumes of castings to four of special egg-shape die-cast zinc alloy slugs that measure, when new, about $\frac{7}{8}$ in. in length and $\frac{1}{2}$ in. in diameter. To this charge is added 200 lbs. of No. 26 Albany sand (which contains about 15% clay) and enough water to cover the charge.

It requires from 24 to 40 hr., depending upon the size, shape and initial condition of the castings, to attain the degree of smoothness required (Fig. 2). Barrels turn, as a rule, at about 18 to 26 rpm. At completion of this tumbling, the charge is dumped, the sand is washed out and the barrel is flushed. Then the charge is screened to separate castings from slugs and the castings are rolled in dry hardwood sawdust in a steam heated, open inclined barrel (back of operator, Fig. 1), for 5 to 10 min. to dry the castings.

After screening to remove sawdust, the castings are transferred to octagonal, wood-lined, one-compartment

barrels of 24-in. diameter. These barrels (Fig. 3), usually turn at 26 rpm. The charge includes 4 volumes of vegetable ivory chips to one of castings and one of hardwood sawdust, to which is added about 8 oz. of a medium-fine flour-like powdered silica. This tumbling is done dry and continues for 18 hrs., at the end of which time scratches left by the sand in the prior wet tumbling are removed and the castings have what is termed a "bright scour." After dumping, the charge is triple screened to separate the castings and to separate the vegetable ivory chips from the sawdust.

Final tumbling of brass and bronze castings is done dry in wood-lined barrels turning at 26 rpm and using a mix that, for three fourths of a cubic foot of castings, contains 3 cu. ft. of vegetable ivory chips, two cu. ft. of soft scrap leather clippings and 6 oz. of powdered nickel rouge. Castings scoured in this manner are bright (Fig. 2) and are sent to stock bins from which they are issued, as required by specific orders, to receive such final finishing as the order specifies. This may be a wheel buff and color or the castings may be plated in various ways or receive a synthetic enamel finish.

Zinc alloy slugs were chosen for the initial tumbling because they are softer than the castings being polished and, in combination with the sand added to the charge, yield the required abrasive actions. The somewhat pointed ends of the slugs get into contact with filleted corners of castings and clean the fillets sufficiently to meet requirements. Other surfaces of the slugs, of course, help to abrade other surfaces of the castings.

Naturally, the slugs wear slowly all over, but they retain their ellipsoidal shape. When cast, the slugs have flash around the smaller diameter but the flash, which is not trimmed off, wears away quickly leaving the entire surface smooth. It is estimated that slugs last about six months, when used an average of 10 hr. a day, and they are kept in use until worn out.

Among the parts that are burred by tumbling are some of cast iron used in Yale door closers and machined within unusually close limits. With such parts,

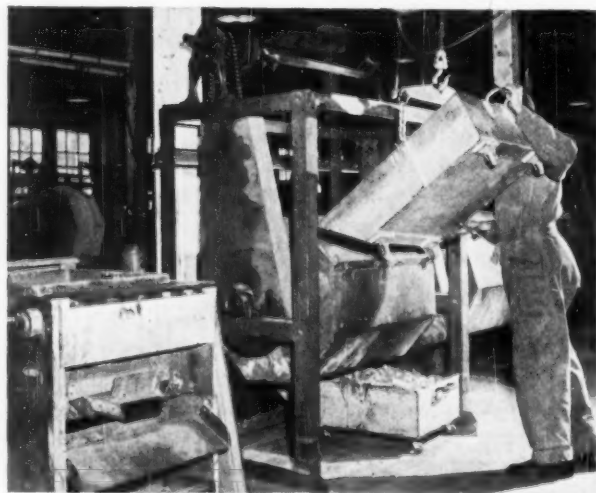


Fig. 3—Loading a mixture of bronze castings in one of the octagonal barrels in which dry tumbling is done with a mixture of vegetable ivory chips and fine abrasive that produce a scouring action.



Fig. 4—Unloading one of a row of wood lined barrels used for wet tumbling of machined iron and bronze castings as well as wrought steel parts that have burrs which are removed by stone chips.

the important dimensions are not changed significantly by tumbling action, but burrs and "feather" or sharp edges are eliminated. Similar deburring work is done also on brass and bronze parts, including some that are cast, such as latch and dead bolts, as well as on some steel parts, including keys.

For deburring the cast iron parts, the proportions used are one volume of parts to 4 parts of No. 3 special tumbling chips. This mixture is placed in 24-in. wood-lined barrels about half full and with the charge submerged in water. Parts are put in and removed by hand so as to avoid nicking edges. It requires only 10 min., with the barrel turning at 26 rpm, to remove the burrs on cast iron parts such as are shown in Fig. 4.

Bronze parts and those of steel are deburred in a mix similar to that for cast iron but the time required is usually 1½ hr. or more. It sometimes takes up to 8 hrs. if burrs are heavy and tough. Non-ferrous parts generally require no other tumbling after deburring, but steel parts are commonly tumbled in double their volume of hardwood sawdust in an open, heated barrel for 10 min. for drying purposes, so as to avoid rusting.

CHEMICAL POLISHING

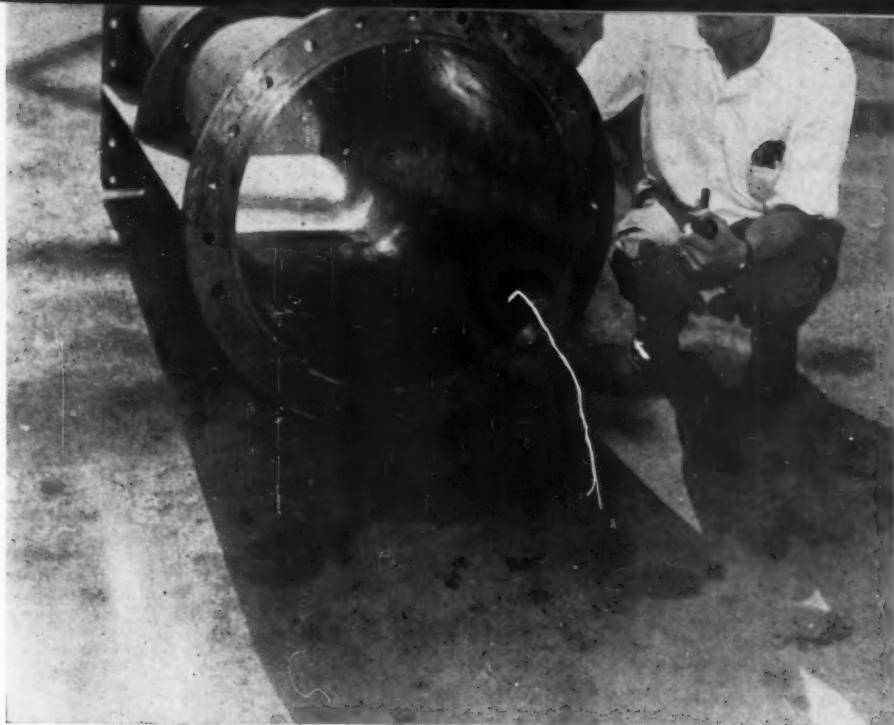
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ished at one time. Brass fireplace screen frames, after receiving a 2-minute chemical polishing treatment, can be color-buffed to a mirror plane surface, the treatment eliminating all other wheel polishing operations normally used.

Brass pocket flashlight cases, brass screws, brass compacts, safety pins, nickel laundry bags, nickel-silver clips used in the dental industry, Monel tubing and spinings, pencil ferrules, and brass license-plate frames are other items that have been treated by the process to acceptable appearance.

Manufacturers wishing to use this chemical polishing process should contact Battelle Memorial Institute, 505 King Ave., Columbus 1, Ohio, for licensing details.

High-velocity wind tunnel transition section lined with .005" of hard nickel for corrosion and abrasion resistance.



Hard Nickel Plating

By M. H. Orbaugh, Head of Electroforming Dept.
Bone Engineering Corp., Glendale, Calif.



The Author

M. H. Orbaugh has been in charge of electroforming at Bone Engineering Corporation for the past three years. Mr. Orbaugh graduated from Purdue University, class of 1935 with a B.S. degree in Chemical Engineering. After graduation he was employed by United Chromium, Inc., first as analytical chemist, later as field engineer. In 1937 he joined the United States Rubber Company to carry out a research and development program in iron electroforming. During the next four years Mr. Orbaugh supervised the development of new uses for iron and nickel electroforming, being appointed Production Manager of the U.S. Rubber Electroforming Dept. in 1941 and serving in this capacity until moving to the West Coast three years ago. In the course of Mr. Orbaugh's fourteen years work in electroforming and heavy deposition of metals he has written several technical articles and is considered one of the authorities in this field.

THE term "hard nickel plating" is a term rather loosely used. It is analogous in its significance to the term hard chrome plating in that it refers to any nickel deposit applied for purely engineering purposes of increasing wear or corrosion resistance, or the building up of worn and mis-machined parts. It is in contradistinction to bright, semi-bright, or other nickel plate applied mainly for decorative purposes. While the majority of hard nickel plating applications do require deposition from the so-called "hard" nickel bath, there are many cases where engineering deposits ranging from very soft to moderately hard are required to meet particular conditions.

In listing the advantages of hard nickel plating it is perhaps easiest to compare it with hard chrome, as this is the most widely used metal in engineering plating today. Since it must be readily admitted that the extreme hardness and low coefficient of friction of hard chrome plate together with its resistance to certain corrosive media cannot be matched in any other metal, it is not intended to imply that hard nickel should always be substituted for hard chrome, but rather that the two metals should supplement one another. Indeed there are many instances where a combination of chrome and nickel on the same parts can be used to advantage.

Using hard chrome as a standard, the advantages of hard nickel plating can be listed as follows:

- (a) Good all around physical properties which can be varied over a wide range. Included among these are toughness. Largely as a result of these good all around physical properties there is much less tendency for deposits to lift, crack or blister in service.
- (b) Hard nickel can be deposited several times faster than chrome with only a fraction of the power required.

- (c) Hard nickel can be readily machined as well as ground.
- (d) Nickel has resistance to a wider variety of corrosive media.
- (e) Nickel has a marked tendency to work harden, which means that the as-plated hardness of a deposit will increase under sliding action in service.
- (f) The superior throwing power of all nickel baths insures more uniform thickness of deposits and eliminates the necessity for conforming anodes in many cases.
- (g) In general, it is more practical to use hard nickel where heavy build-up is required. Where it is desirable that the finished surface meet conditions of extreme wear or hardness most of the build-up required can be rapidly deposited with nickel and then finished off with a few thousandths of chrome.
- (h) In cases where a surface must be built up to run in contact with a chrome plated surface, nickel should be used to prevent galling action. An example of this is in the salvage of worn or mis-machined hydraulic pump cylinders where the plunger is chrome plated and the barrel is oversize.
- (i) The temperature coefficient of nickel is much nearer to that of steel than chrome is, making hard nickel plating ideally suited to high temperature applications such as glass Lehr rolls and parts running in contact with super-heated steam.

Applications

Applications where hard nickel plating has already proved successful, together with potential applications, cover practically every field of industry. Chief among these are oil tools, food processing equipment, railroads, bus lines, paper and textile mills, printing, machine shops, and the aircraft industries.

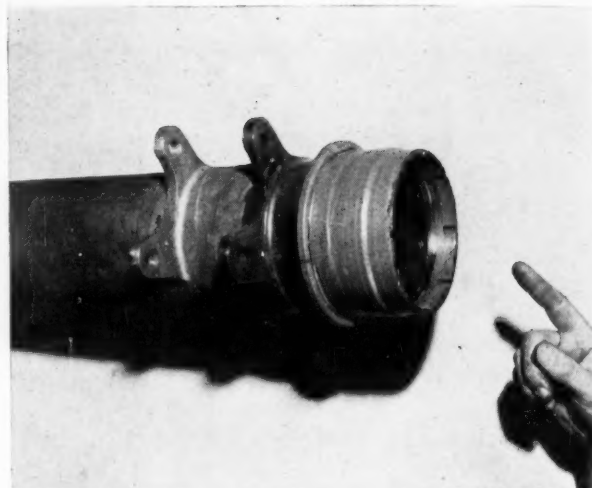
Hard nickel plating can be divided into four general classifications:

- 1—Salvage of worn parts.
- 2—Salvage of mis-machined parts.
- 3—Improvement of new parts.
 - (a) increasing of wear resistance or hardness.
 - (b) imparting combined wear and corrosion resistance.
- 4—Lining of industrial equipment for corrosion resistance.

It is interesting to note that the *Fescol Co. Ltd.*, of London, Eng., has been profitably engaged in various phases of hard nickel plating for the past 30 years and has recently opened two new plants, one in England and one in France.

Physical Properties of Deposits

A wide range of controlled physical properties to meet a variety of engineering requirements is made possible by the use of three basic types of nickel baths. Typical properties of deposits obtained from these baths are as follows:



Aircraft landing gear strut re-sized with .020" of hard nickel on the thread diameter.

Type of Bath	Tensile (psi) Strength	Hardness (Vickers)	Elongation % in 2"
Low pH Watts bath	50,000	150	30
All chloride bath	100,000	260	15
Hard bath	150,000	375-450	6-8

The crystalline structure of the soft Watts deposit is large and elongated perpendicular to the plane of the base metal.

In the moderately-hard all-chloride deposit the grain size is much smaller and there is no preferred orientation. The grain size of the hard bath deposit is still smaller and the grains are also oriented at random.

Hard nickel deposits do not have the tendency to form networks of fine macroscopic cracks as is common with all chrome deposits due to their high internal stresses. This fact accounts for the higher corrosion resistance of relatively thin deposits of nickel on steel compared to an equal thickness of chrome plate on steel.

Rate of Deposition

The relative plating speeds of chromium and nickel are as follows:

	Current Density	Inches per hr. deposited
Nickel	50 asf	.0025"
	100 asf	.005"
Chromium	150 asf	.0004"
	300 asf	.001"

Solutions and Operating Conditions

A recommended formula and set of operating conditions for producing heavy deposits that are soft and ductile is:

Single nickel salts	44 oz/gal
Nickel chloride	4 oz/gal
Boric acid	4 oz/gal
pH	2.0-2.5
Temp.	140°F
Current Density	40-80 amps/sq. ft.
Agitation	Yes
Anodes	Hi-purity, rolled, annealed, carbonized.

The Deposition of Copper from Phosphoric Acid Solutions

By C. B. F. Young, Adjunct Prof., Brooklyn Polytechnic Institute, Brooklyn, N. Y. and Fred. I. Nobel, I. D. Watchcase Co., Jamaica, N. Y.

A RECENT review of the literature on copper plating baths in existence today reported a large variety of electrolytes, many of them in use commercially.¹ Since the appearance of this review, three new solutions have been proposed, all of them acid. *Stareck* and *Passal* proposed a solution containing copper sulfate, formic acid, and ammonia. The solution has a pH of 2 to 4 and the authors claim that this bath can plate at a higher current density than any other known bath. *Struyk* and *Carlson* presented a solution containing copper fluoborate and fluoboric acid. This solution plates with high anode and cathode efficiencies, and relatively high current densities. The deposit is fine-grained and ductile. *Faust*, *Agruss*, *Combs* and *Proell* introduced a solution containing a copper salt of alkylsulfonic acids. The solution was prepared by dissolving basic copper carbonate in an acid mixture of methane, ethane and propane sulfonic acids. Current densities ranged from 60 to 1000 amps/ft² with agitation. Throwing power is approximately the same as with the fluoborate bath and is typical of the acid copper solutions. The deposit is semi-bright at high current densities.

The object of the investigation reported in this article was to find a copper complex with a phosphorus compound, other than the pyrophosphate, that will plate with superior results, operate at a pH close to

neutral, plate directly on iron without the use of a copper "strike" solution, form a stable solution, and be cheap.

Preliminary Experiments

All the known phosphates were obtained and tested for complex ion formation with copper. In each case, pH was varied from highly acid to highly alkaline. Wherever a complex ion formed, a plating bath was prepared and tests made to determine the character of plate, current density range, and bath characteristics. The following compounds were tested: Sodium Hypophosphite (NaH_2PO_2), Sodium Phosphite (NaH_2PO_3), Sodium Orthophosphate (NaH_2PO_4), Sodium Metaphosphate (NaPO_3), Sodium Hexametaphosphate ($\text{Na}_6(\text{PO}_3)_6$), Sodium Tripolyphosphate ($\text{Na}_3\text{P}_3\text{O}_{10}$), Sodium Tetraphosphate ($\text{Na}_4\text{P}_4\text{O}_{13}$).

No complex was formed with sodium hypophosphite.

Sodium phosphite formed a complex, and a clear blue solution was obtained at a pH of six. However, the phosphite is oxidized to the orthophosphate upon standing and also while plating. Copper orthophosphate precipitated out of solution at this pH.

Sodium orthophosphate formed a clear, stable solution with copper sulfate at pH values below 1.35. At higher pH values, copper orthophosphate precipitated.

Sodium metaphosphate formed a complex with copper at pH6. Upon standing for a short while, however, a precipitate of copper orthophosphate formed.

Sodium hexametaphosphate formed a complex at pH4. This solution is similar to the metaphosphate and precipitated copper orthophosphate upon standing.

Sodium tripolyphosphate formed a complex at pH6. Plating from this solution was unsuccessful due to a precipitate forming on and completely covering the anode during plating. Further precipitation takes place upon standing, showing that a breakdown to the orthophosphate takes place.

Sodium tetraphosphate formed a complex at pH4. Plating from this solution was similar to plating from the conventional copper pyrophosphate bath according to preliminary tests. However, upon standing, a precipitate formed in the solution due to a slow breakdown to the orthophosphate.

It was apparent, then, that the only phosphate forming a stable plating bath with copper was the orthophosphate at low pH. The plating solution would contain copper phosphate and phosphoric acid, making it somewhat similar to the conventional copper sulfate-sulfuric acid bath.

Attempts to form the phosphate bath by dissolving commercial copper phosphate in phosphoric acid met with failure. Further experiments proved if the copper phosphate is freshly precipitated, only then can it be



The Author

A graduate of the College of the City of New York, Mr. Nobel received his Master's Degree at Brooklyn Polytechnic Inst. Before joining the I.D. Watch Case Co. he spent five years as an inspector of aircraft engineering materials for the Bureau of Aeronautics of the U. S. Navy. The manuscript reported in this article was part of his Thesis for his Master's Degree.

completely dissolved by phosphoric acid. The solution can be prepared by dissolving basic copper carbonate in phosphoric acid and driving off the carbon dioxide. The simplest method of preparation, however, is dissolving copper oxide in phosphoric acid. The results of the last two methods give the desired solution consisting of copper phosphate and an excess of phosphoric acid.

In order to determine optimum conditions for plating from the copper phosphate bath, the following variables were studied in the Hull Cell: effect of preparing the plating bath with copper sulfate instead of copper oxide; effect of PO_4/Cu molar ratio; temperature; pH; concentration of solution; and effect of NH_4 , Na, and K.

Method of Preparing the Bath

Two solutions were prepared with the same copper and phosphate ion concentrations, but in one case copper ions were supplied by copper oxide, and in the other by copper sulfate. Hull Cell plates were prepared with all other variables equal. Identical plates were obtained, showing that the large excess of sulfate ions added with the copper sulfate had no effect on the plating characteristics of the solution. Upon standing, however, copper sulfate precipitated out of solution until 215 g/l (28.7 oz/gal) remained. At this concentration, the amount of copper metal in solution was too low to plate with optimum characteristics. When copper carbonate was used to prepare the solution, as much as 180 g/l could be dissolved. For the equivalent amount of copper metal, 419 g/l of copper sulfate would be necessary. No crystallization took place even at this high concentration when there was no sulfate present, and the solution consisted only of copper and phosphate ions. This rules out copper sulfate as a source of copper.

Molar Ratio of PO_4/Cu .

The effect of the molar ratio PO_4/Cu was studied with the Hull cell, using solutions with the following ratios: 1:2, 1:1, 2:1, 3:1, 4:1. When the ratio was 1:2, the plate looked somewhat like that from a conventional sulfuric acid copper bath, with a short burnt area at the high-current-density end and with the rest of the plate gradually changing from a dull to a semi-bright plate toward the low-current-density end. As the ratio was increased, the burnt area grew larger, whereas the dull and semi-bright areas finally became one bright zone. Thus, removing free copper ions from solution by the addition of a common ion had two effects on the plate: 1. the maximum permissible current density was reduced, 2. a bright plating range appeared and became brighter and larger. A point was reached beyond which the undesirable result of (1) over-shadowed the desirable result of (2). This point occurred at a ratio of 3.75:1, which is the optimum value used for the plating solution.

Temperature

Plating tests were made at the following temperatures: 23°C. (73.5°F.), 35°C. (95°F.), 50°C. (122°F.), 70°C. (158°F.). At the low temperature,

the burnt area was very wide, and decreased to a small area as the temperature was raised to the high value. The bright area, however, became duller as temperature was raised, until, at 50°C., the bright area became semi-bright, and, at 70°C., this area became dull and coarse grained. Increasing temperature resulted in a decrease in the throwing power of the solution as shown by the growth of an area of no coverage in the low-current-density end of the plate. The only beneficial result of increasing temperature was that the maximum permissible current density was increased. Beyond 35°C., this increase was offset by the decrease in brightness, therefore this 35°C. was the optimum value.

pH was varied by additions of concentrated sulfuric acid. Large amounts of acid are needed to bring about a change in pH since the phosphate serves as a buffer.

No great change accompanies a decrease in pH. As prepared without sulfuric acid, the pH of the solution is 0.8. At this point, the areas of no plating and partial plating are fairly large, thereby decreasing the bright area. Upon decreasing pH, the areas of no plating and partial plating decrease, and the bright area increases. The burnt areas increase with decrease in pH but only to a slight degree. In addition, the conductivity increased with decrease in pH.

However, beyond a pH of 0.4, the increase of conductivity and decrease of areas of no plating and partial plating are offset by the undesirable effect of decreasing the permissible current density range. Furthermore, greater additions of sulfuric acid adds sulfate ions which will decrease the solubility of copper in solution. The pH of 0.5 is the optimum value.

Concentration

The test plates show that there is not much change in varying concentration. At a concentration of 100 gm/l copper carbonate (13.3 oz/gal), however, the bright range becomes markedly smaller. Conductivity increases with decrease in concentration. "Dragout" will increase with increased concentration.

It is seen, therefore, that the concentration should be kept as low as possible without sacrificing brightness. The lowest value that satisfies this condition is 125 gms/l (16.8 oz/gal) copper carbonate and this is the optimum value.

Potassium and Ammonium Ions

To determine the effect of the additions of K^+ and NH_4^+ in the form of the alkali phosphates, a series of tests were run. It was seen that no detrimental effect resulted and of the two, the NH_4^+ ion is more desirable since it would permit higher current densities. However, since the pH is increased by their presence as phosphates, and no apparent beneficial effects are forthcoming, it is recommended that they be excluded from the bath.

Study of Sulfuric Acid Copper for Comparison with Phosphoric Acid Copper

The orthophosphoric acid bath is similar to the sulfuric acid in that the pH is very low, copper is in the divalent state, and the chemical content is similar. In

the one case there are copper sulfate and sulfuric acid, and in the other case there are the equivalent of copper phosphate and phosphoric acid.

Hull cell studies show that the sulfate bath permits higher current densities at equal temperatures. The phosphate bath has a bright range at the higher current density values but at these same values, the sulfate bath plates dull. At lower current density values, the copper sulfate bath has a bright range but at these same values the copper phosphate is dull.

The variation with temperature is the same for both baths. Lower temperatures, slightly above room temperature gives a brighter, smoother plate and the throwing power is highest. At the higher temperatures the bright areas become duller and at 70°C. (158°F.), the plate is coarse grained. The covering power becomes very poor at these high temperatures as shown by the wide areas of partial and no plating. In this respect, both baths are similar. It will be shown later that the throwing power of the sulfuric copper bath is better than that of the phosphoric copper.

Thus it is seen that the advantages of the phosphoric copper bath over the sulfuric copper bath are:

1. Brighter deposits are obtainable.
2. These brighter deposits are obtainable at a high current density range.

Disadvantages are:

1. Throwing power is lower than the sulfuric copper.
2. Limiting current density value is lower than the sulfuric copper.
3. Solution concentration is higher, making for a more expensive solution, greater dragout, and more difficult to prepare than the sulfuric copper.

Current Efficiency Study

The cathode current efficiency is very close to 100% in low current density ranges, the actual value averaging 98%. As current density increases, the efficiency falls very gradually until, at a current density where burnt deposits occur, the efficiency drops rapidly.

The anode current efficiency is greater than 100%, showing that some copper is being discharged, or being dissolved chemically, in the cuprous condition. As current density is increased, the current efficiency approaches 100%. At very high anode current densities, such as 150 amps/ft² (16.2 amps/dm²), gassing will take place at the anode and then the current efficiency falls considerably below 100%.

Agitation

Agitation has the effect of spreading the Hull cell plate out to the higher current density values. Current efficiencies are maintained high even at very high current densities. Burnt deposits do not occur on the cathode until approximately 300 amps/ft² (32.3 amps/dm²) is reached. Anode current efficiencies are kept close to 100% due to solution agitation caused by the rotating cathode.

The rotating cathode was revolving at a speed that made the speed of a point on the cylinder travel at 60 ft/min (30.5 cm/sec). At this speed, current efficiencies are slightly over 100%, showing that some

of the copper is being deposited from the monovalent condition. The deposit is smooth and fine-grained until 300 amps/ft² (32.3 amps/dm²) is reached and then burning occurs at the edges.

It is believed that more effective agitation would make this value much higher than 300. It is evident that agitation is desirable in this solution.

Throwing Power

Many tests were made in the Haring cell in an attempt to improve the throwing power. The PO₄/Cu ratio was varied above and below the optimum value of 3.75 but the low value gave a throwing efficiency of 1.2% and the high value yielded 0%. Increasing the pH by making up the bath without adding sulfuric acid decreased the throwing efficiency. This was probably due to the lowering of conductivity which decreased the throwing efficiency. Lowering the pH, which increased the conductivity, raised the throwing efficiency from 0 to 10%.

Increasing the current density decreased the throwing efficiency. Increasing the temperature above 35°C. (95°F.) decreased the throwing power considerably. This effect of temperature on the throwing power of the solution was also noted in the Hull cell tests at high temperatures, where the areas of lower current density showed little or no plating.

No tests were made in the Haring cell with addition agents, but a Hull cell test indicated that the throwing power is improved somewhat by adding gelatine in the concentration of 0.05 gms/l (0.0067 oz/gal).

In a comparison of the throwing efficiencies from various copper plating solutions, it was noted that a proprietary high speed plating solution was the highest with 82.5%, the Rochelle-cyanide solution was next with 66.7%, the sulfuric acid copper is next with 18.8% and the phosphoric acid copper is lowest with 11.0%. Thus the cyanide solutions have much better throwing power than either of the two acid solutions, but the phosphoric solution is lowest of all. It may be that some addition agent exists which will increase the throwing efficiency of the phosphoric copper bath considerably. The author has not made this study, however, and this is a suggestion for future work.

The best conditions for producing the highest throwing efficiency from the phosphoric copper bath are also those for producing the best plate as determined in the Hull cell.

Covering Power is very similar to throwing power but does not give a quantitative result. A low current Hull cell test of 0.2 amps total (0.4-1.2 amps/ft²) (0.0043-1.3 amps/dm²) is made and the lowest current density noted when the plate still covers the cathode. However, this result varies with cleaning methods and preparation of the cathode for plating, therefore, it can only be used as a comparison test.

Comparison with the sulfuric acid copper showed that this solution has slightly better covering power than the phosphoric copper.

Brightening Agents

A number of organic addition agents were tested in an attempt to plate a bright deposit. All the better

known addition agents for the sulfuric acid copper were tried with varying results. Most of these showed little or no effect on a short time plating test. Some of these may have a beneficial effect on a heavy deposit, but long period plating tests were not made on these addition agents since they did not give a "true" bright deposit. Thus phenosulfonic acid, licorice root, formaldehyde and sodium formate, molasses, and caffeine were discarded as not having a suitable beneficial effect.

Gelatine was found to have a marked brightening effect. Agitation was needed to obtain an even deposit and a current density of 50 amps/ft² (5.4 amps/dm²) was used. Dextrin, another colloid, was also beneficial in producing a brightening effect. In both these cases, the concentration of addition agent was very low, 0.05 to 0.1 (0.0067-0.013 oz/gal) gms/l with the lower value being best. In addition to brightening, the effect was also to increase permissible current densities. However, the colloids did not produce mirror-bright deposits. Deposits were semi-bright and ductile. Thiourea gave mirror-bright, but uneven deposits. Thiourea and gelatine together gave mirror-bright, deposits that were even, and a heavy deposit was made using these two agents. The resultant plate was very bright but very brittle. Thus it appeared that the N—C = S—N group gives the brightening effect.

In order to obtain a bright and ductile deposit, urea was tried. It was hoped that substituting an O for an S, urea for thiourea, would solve the problem; however, this made for a loss of brightness.

The C = S group alone was tried in various forms but the effect was a harmful one. The C—C = S—N group was tried with results similar to the C = S group.

This indicates clearly that the thiourea group is definitely needed for a brightening effect. Allyl thiourea and gelatine was the solution to the problem. This combination produced a mirror-bright, ductile deposit at 50 amps/ft², 35°C., solution agitation. (5.4 amps dm², 95°F.).

It is believed by the writer that a suitable modifier could be found which, in conjunction with thiourea would also give the desired effect and would be a much cheaper addition agent than the allyl thiourea. Some combinations were tried with negative results.

Character of Deposit

Without addition agents, the heavy deposit is ductile, smooth, and consists of fine grains as viewed by the microscope. A mirror-bright finish can be obtained with very little buffing. The color of the deposit is slightly redder than that from the sulfuric bath.

With the allylthiourea and gelatine addition agents, the deposit is ductile, smooth and mirror-bright without buffing. As with bright nickel, bright copper from cyanide solution, and other bright deposits, the grains are too small to be seen under the microscope with 500 magnification.

Conclusions

A new copper plating solution was developed and an addition agent found which will give mirror-bright

deposits at any thickness of plate. Bath composition for best results is:

Copper oxide, CuO	=	93	gms/l	*	12.5	oz/gal
(or)						
Copper carbonate,						
CuCO ₃ ·Cu(OH) ₂	=	130	gms/l	*	17.4	oz/gal
Phosphoric acid,						
H ₃ PO ₄ sp.gr.—1.7	=	500	gms/l	*	79.5	oz/gal
Sulfuric acid,						
H ₂ SO ₄ sp.gr.—1.86	=	37	gms/l	*	4.9	oz/gal
pH	=	0.5				
Temperature	=	30° C		*	86° F	
Gelatine	=	0.05	gms/l	*	0.0067	oz/gal
Allylthiourea	=	0.2	gms/l	*	0.027	oz/gal

Agitation is necessary for bright deposits and high current densities.

Current density = 15 to 50 amps/ft² * 1.6 to 5.4 amps/dm² and higher with better agitation.

Throwing efficiency is 11% from the bath, without addition agents, and at 35 amps/ft² (3.75 amps/dm²) and 30°C. (86°F.).

Anode corrosion is very good and both cathode and anode efficiencies are very close to 100%, with the latter slightly greater than 100%.

Iron and steel cannot be plated directly and should be given a "strike" in a cyanide bath prior to plating in this solution.

HARD NICKEL PLATING

(Concluded from page 55)

Stop Offs

Conventional wax and stop off lacquers are used for masking purposes in hard nickel plating. Parts should always be degreased, alkaline cleaned and scrubbed whenever possible before applying the stop off.

Machining

To obtain best results in the machining of hard nickel deposits, a high-cobalt low-molybdenum tungsten tool steel of the 18-14-1 type should be used. The tool should be set approximately 1/64 inch below center and all clearances should be 10°. The cutting angle recommended is 70°. Cuts should start from the center of the deposit and feed towards the rough edges. The use of a soluble oil lubricant is advisable.

When grinding nickel deposits special wax compositions which prevent loading of the wheel should be used to obtain speed and quality of finish.

Costs

The cost of hard nickel plating in general is about that of hard chrome plating for relatively thin deposits but usually is appreciably less for heavier deposits due to the faster rate of deposition for nickel and the decreased power required.

In conclusion let it be pointed out that, like any other commercial process gaining recognition on a large scale, a great many of the possible applications of hard nickel plating will not be immediately apparent and will require ferretting out and selling to be done. In general the potential customers of the hard nickel plater lie with anyone engaged in the manufacture of or use of equipment which is subject to wear or corrosion and with anyone manufacturing parts which may be mis-machined.

The Fatigue Limit of Chrome Plated Aircraft Steels

Tech. Report 1379, National Bureau of Standards, Wash., D. C.

IN addition to decorative use on such articles as automotive headlights and bathroom fixtures, chromium plating is widely used on gages, cylinder walls, piston rings, and other machine parts where resistance to wear is an important factor. However, the advantages of chromium plating, in the absence of proper precautions, may be offset by the adverse effect of the plating on the fatigue limit¹ of the basis metal. Recently *Hugh L. Logan* of the National Bureau of Standards made an extensive study of the effect of chromium plating on the fatigue limit of steels used in aircraft. This investigation,² sponsored by the Bureau of Aeronautics, Department of the Navy, provides information of interest not only to aircraft manufacturers but also to a number of other industries which produce or utilize chromium-plated machine parts.

Specimens about $\frac{1}{4}$ inch in diameter were machined

from three lots of SAE X4130 rod and one lot of 6130 rod (Table 1). The X4130 steel was either normalized to a Rockwell hardness of 90-B or quenched and tempered to a hardness of about Rockwell 40-C, while the 6130 steel was quenched and tempered to a Rockwell hardness of 33-C. After grinding, polishing, and chromium-plating, the specimens were subjected to fatigue tests in the R. R. Moore type of rotating-beam machine operating at 1,800 or 3,600 revolutions per minute. Eight or 10 specimens usually were required to obtain the fatigue limit for any one set of conditions.

In all cases chromium plating was found to reduce the fatigue limits of the steels studied, although the effect was less pronounced under some conditions than others. In general, the reduction in fatigue limit increased with increased hardness of the steels. For steel of a given hardness, the fatigue limit decreased

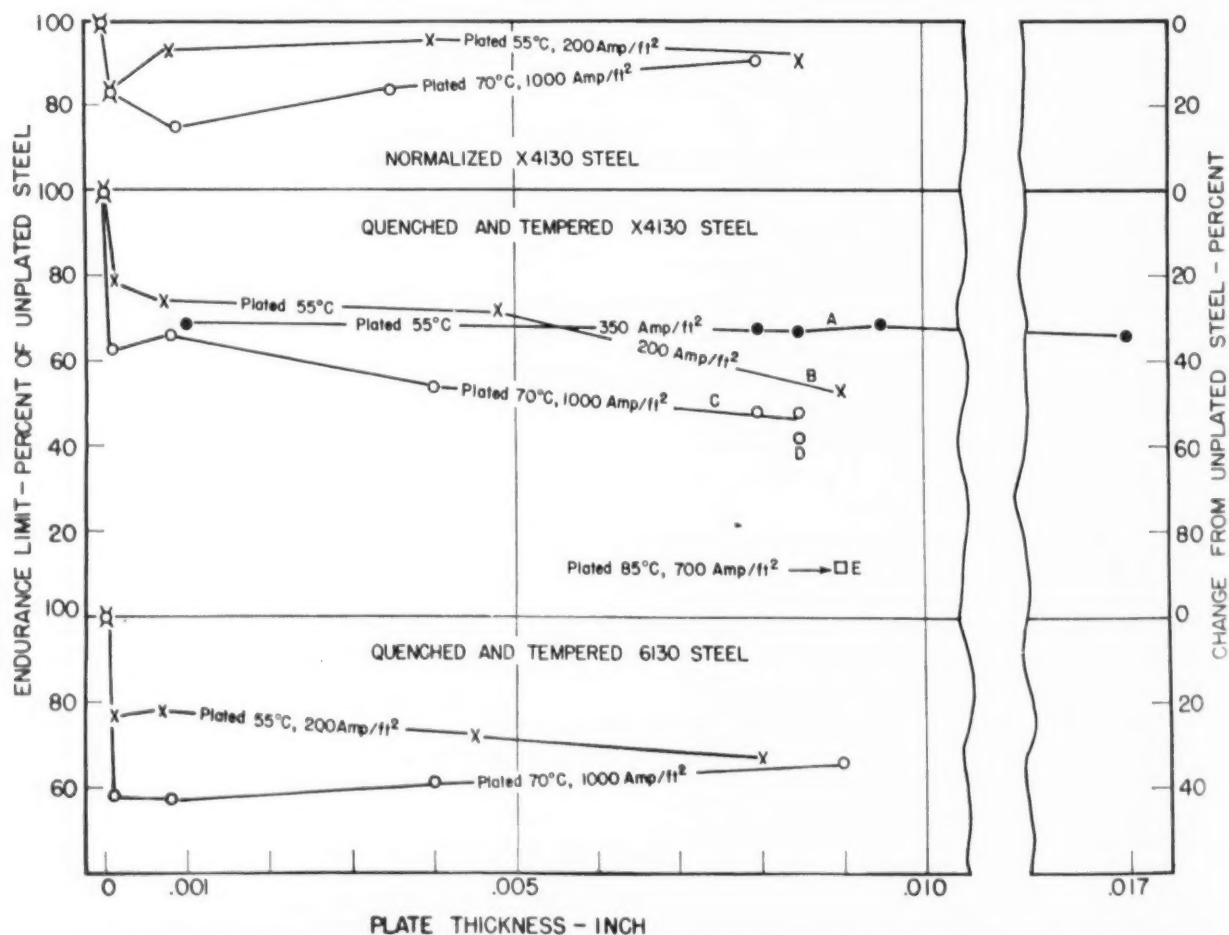


Figure 1—Relationship between endurance limits and plate thicknesses of SAE X4130 and 6130 steels as shown in experiments at the National Bureau of Standards.

TABLE I

Composition of Steels Used in Studying the Influence of Chromium Plating on Their Fatigue Limits.

Element	SAE X4130			SAE 6130
	Lot A Percent	Lot B Percent	Lot C Percent	Percent
Carbon	0.35	0.29	0.33	0.30
Manganese	.53	.47	.55	.61
Phosphorus	.01	.02	.03	.03
Sulfur	.02	.02	.01	.04
Silicon	.21	.25	.24	.25
Chromium	.95	.96	1.05	1.01
Molybdenum	.19	.24	0.20	*
Vanadium	*	*	*	.22
Nickel	*	.15	.17	*

* Not determined.

with increased temperature of the plating bath. While plate thickness appeared to have little effect on the fatigue limit of specimens plated in a bath at 55°C. and a current density of 350 amperes per square foot, no generalizations could be made regarding the effect of this factor at other current densities and temperatures (Fig. 1).

It was discovered that the fatigue limits of specimens plated and subsequently ground to remove a part of the plating were equal to or greater than those of specimens initially plated to the same thickness as the ground specimens and tested as plated. Other experiments showed that interruptions of the plating process did not reduce the fatigue limit of the plated specimens provided proper precautions were taken for continuing the plating.

Chromium-plated objects often are heated to temperatures between 90° and 200°C. with the object of improving their mechanical properties by expelling the hydrogen deposited with the chromium. A systematic study was therefore made of the effect of heat-

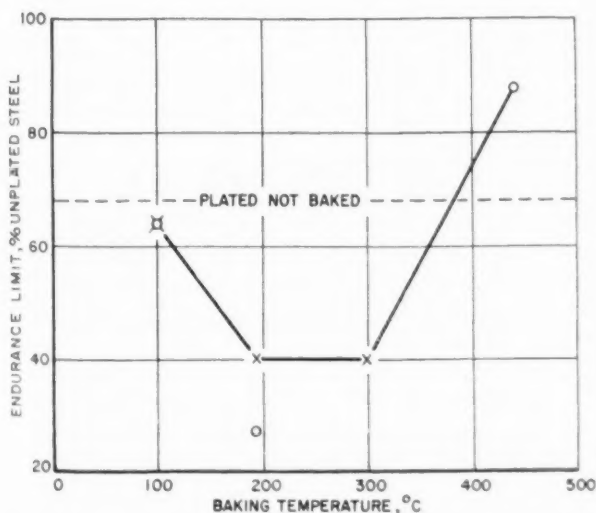


Figure 2—Effect of baking temperature on the fatigue limit of SAE X4130 steels in experiments carried out at the National Bureau of Standards. Circles indicate specimens baked in air and crosses specimens baked in organic liquids.

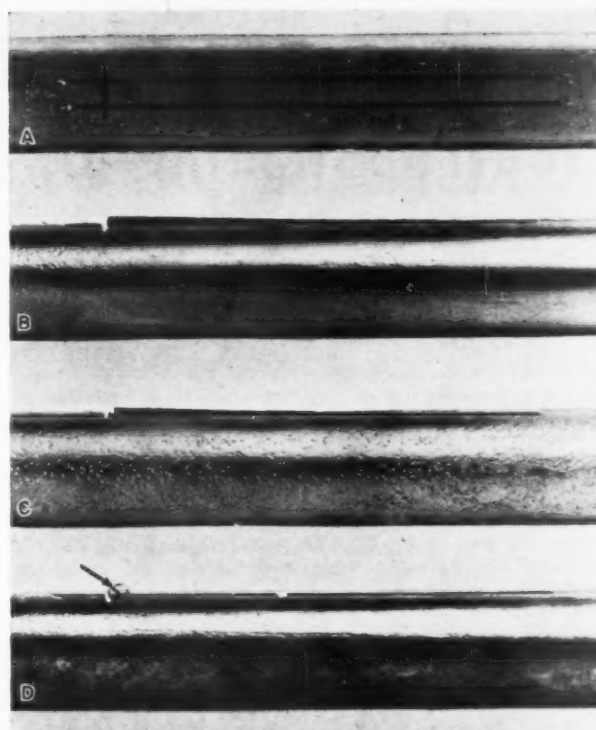


Figure 3—The effect of heat treatment on the residual stresses in chromium-plated steels was illustrated at the National Bureau of Standards by means of "tongues" cut in thin-walled tubes of annealed steel. (A) Top view of tube showing tongue (B, C, and D) side views of tubes showing deflection of tongue. (B) Tube plated, heated at 200°C, and tongue subsequently cut. (C) Tube plated, tongue cut, and tube subsequently heated at 200°C. (D) Tube plated, heated at 440°C, and tongue cut; a 3/16-inch ball bearing (indicated by arrow) is resting on the depressed tongue surface.

ing on the fatigue limit of chromium-plated steel. The results showed that the fatigue limits of quenched and tempered specimens heated after plating decreased to a minimum value for some heating temperature between 100° and 300°C. and thereafter increased with increased heating temperatures (Fig. 2). Fatigue limits of specimens heated for 1 hour at 440°C. in some cases were 87.5 percent of that of the unplated steel, whereas fatigue limits of specimens plated but not heated, and of specimens heated 1 hour (in air) at 193°C., were only about 68 and 27 percents, respectively, of those of the unplated steel.

Three possible causes for the adverse effect of chromium plating on the fatigue limits of the steels were (1) the embrittling effect of hydrogen deposited with the chromium, (2) cracks in the chromium, and (3) residual stresses in the chromium. However, it was shown that there was no simple relationship between the fatigue limit and the amount of hydrogen remaining in the chromium after a baking treatment. Further experimental evidence indicated that cracks present in the chromium were not the principal cause of the reduced fatigue limits of the plated steels.

It is generally agreed that residual stresses in a material markedly affect its fatigue limit. Thus, in steel, compressive stresses, such as are produced by shot peening, increase the fatigue limit; tensile stresses have the opposite effect. In order to show the presence of tensile stresses in electrodeposited chromium and the effect of heat treatment on these stresses, thin-walled
(Concluded on page 98)

The Safe Use of Perchloric-Acetic Electropolishing Baths

By Dr. Pierre A. Jacquet, Paris, France.

Editor's Note

In this article the author reveals the general conditions for the safe use of electropolishing baths containing perchloric acid and acetic acid, which he has pioneered and recommended since 1931. The disastrous explosion of such a bath in Los Angeles several years ago brought out the necessity for a systematic study of the conditions under which these most useful baths will explode. He summarizes the recent research on this subject in France by Medard and Sartorius, the results of which will be re-assuring to those who are using or would like to use such mixtures for electropolishing a wide range of metals.—ED.

SEVERAL of the electrolytes used for the polishing of metals and alloys are composed of mixtures of perchloric acid with organic materials such as acetic anhydride, or acid, and alcohols.

It is known that under certain conditions, for example in a concentrated state, under heat and in the presence of certain organic bodies, perchloric acid may give rise to violently explosive reactions. These explosions have been effectively observed in the practice of electrolytic polishing, but to tell the truth, they are extremely rare in relation to the extensive use of processes calling for this mixture.

Of these accidents, that which destroyed an American factory using a very large electrolytic polishing bath in February 1947, has caused an apprehensive feeling among those who use the process for the preparation of small samples. This is why it is very important to understand the conditions which were the cause for the accident. The meager information given in the literature did not allow a formal conclusion with respect to the potential danger of perchloric-acetic mixtures, thus it was indispensable to undertake a research program on this subject. We will give in this article the essential results of the research performed in France by *L. Medard* and *R. Sartorius*.

The Properties of Perchloric Acid

In most laboratories perchloric acid is generally used in the form of aqueous solutions containing from 65% of HClO_4 (commercial concentration in France) to 70 to 72% of HClO_4 (commercial concentration in the U. S. A.). The 72% solution corresponds essentially to the dihydrate (containing 73.6% of acid) and to the azeotropic mixture boiling at 203°C. (containing 72.5% of acid). There are five other hydrates known having a water content varying between 1 and 3.5 moles per mole of acid.

Although perchloric acid in aqueous solution at concentrations no higher than 72% is stable and may be handled without danger by using a few elementary precautions, the anhydrous or very slightly hydrated acid is a very dangerous product whose formation

should be avoided. It is stable at the temperature of liquid air but is subject to decomposition at ordinary temperatures. This decomposition would be due to the presence of a small quantity of free anhydride in equilibrium with the acid and susceptible to the liberation of chlorine dioxide and oxygen. The latter is evolved and the ClO_2 remains in the liquid, which becomes progressively more colored. The acid may then explode spontaneously with great violence. One would think that with traces of impurities playing a specific part in the decomposition, that this would then be less to be feared with pure acid.

Aqueous perchloric acid is a reagent widely used in laboratories. At ordinary temperatures it is a strong acid giving well defined salts. It behaves as a mono-acid and displaces strong volatile acids (hydrochloric and nitric), but not sulfuric acid except when insoluble perchlorates are formed. Perchloric acid possesses an abnormal solubility in a certain number of organic liquids (alcohol, ether, etc.), such that in these non-aqueous solutions it is the strongest known acid.

Among the uses of perchloric acid in chemical analysis we cite the identification and determination of the potassium ion in the form of the perchlorate, KClO_4 . This salt is poorly soluble in water and still less soluble in ethyl alcohol so that one may precipitate it in the presence of alcohol by means of perchloric acid. If one attempts to remove the remaining alcohol by heating a very sudden explosion will result.

The oxidizing properties of perchloric acid in the cold are negligible even in the presence of powerful reducing agents. On the contrary, solutions containing more than 60% of acid present an extremely active oxidizing agent when warm, capable of oxidizing trivalent chromium to the chromate and ferrous iron to ferric iron. The mode of action of perchloric acid on organic materials is very complex. *Roscoe* has formerly shown that the anhydrous acid reacts in the cold in an explosive manner with alcohol, ether, paper, wood, carbon, etc. The monohydrate of the acid is less violent but still produces a total combustion of organic materials. It is only at concentrations no more than 72% that the reactions can be conducted without danger.

According to *E. Kahane*¹ the action of aqueous solutions of perchloric acid on organic materials has not been well studied because of fear of explosions observed by *Roscoe* with the anhydrous acid. It is thus that we have established a confusing view leading to the belief that the reaction is always extremely lively, even dangerous. In reality no reaction occurs with organic materials on which technical perchloric acid (density 1.60, containing 65% acid) is reacted

in the cold or at moderate temperatures, except by esterification or dehydration, but not by oxidation. However, heating nearly always establishes a more or less vigorous reaction whose rate depends upon the conditions of heating, the proportions, the quantities used, and above all, the particular organic material.

With respect to this latter point (the nature of the organic substance), again according to *Kahane* the activity of perchloric acid is not manifest in a uniform manner: it may proceed in a nearly explosive manner or nearly completely indifferently. This is, moreover, the reason why in chemical analysis, the acid may not be used alone for the destruction of organic materials. One notices that it is only with respect to relatively simple substances that perchloric acid behaves rather indifferently, even hot. Thus, for the destruction of stearic acid, even incompletely, it is necessary to operate near 200°C. On the other hand, complex substances (gum, rosin, carbon) undergo a rapid, complete solubilization which sometimes, taking oil for example, assumes a quite dangerous aspect.

The explanation of the eminently variable behavior of perchloric acid with respect to organic matter is not yet very clear. *E. Kahane* admits that the action of the acid is more destructive than oxidizing. It acts as a "breaking" reagent and it is by means of a sort of "cracking" that it mineralizes the organic materials. One concedes then that the nature of the bond of the organic molecules would be a factor determining the course of the reaction.

Even if perchloric acid does not behave most often as an oxidant, it is nevertheless a material rich in oxygen. As a general rule the combination of such a body with one or more oxidizable materials constitutes an explosive. The explosive character of the mixture

then depends upon the nature of the materials mixed, their proportions and the degree of intimacy in the mixture. In particular, when the mixture is a solution (mixture in the molecular state) it may constitute both a sensitive and violent explosive. This explains the divers reports of the laboratories pointing out explosions in the course of operations where perchloric acid was heated in the presence of various organic compounds.² Recently the *Bureau of Mines* of the United States³ has made a study of the dangers of mixtures with rubber, linoleum, wood flour, raw cotton, lubricating oils, turpentine, etc. This work concludes that many of these mixtures are sensitive explosives.

Composition, Preparation and Use of Aceto-Perchloric Polishing Baths

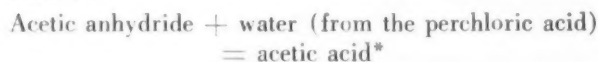
Perchloric acid has found an important application in the field of electrolytic polishing. The particularly unique properties of this acid, particularly its easy solution in numerous non-aqueous solvents, its powerful dissolving action with respect to metals and their alloys, with the possible formation of complex ions, and the appreciable solubility of many of the metallic perchlorates in acid media, are doubtless responsible for the fact that this acid has been shown to be a fundamental constituent of electrolytes for the polishing of the majority of industrial metals and alloys. One may distinguish between two principal types of baths containing perchloric acid. The first is composed of mixtures of this acid with acetic anhydride (acid). In the second type the acid is added, generally in small proportions, to methyl or ethyl alcohols, with or without the addition of other organic materials

TABLE I.
Composition of the Principal Polishing Baths
Containing Perchloric and Acetic Acids.

Bath No.	Metals Polished	HClO ₄ (d.=1.48) c.c.	(d.=1.60) c.c.	Acetic anhyd. c.c.	Acetic acid c.c.	Water added c.c.	Reference
1.	Al, Ni-Cr steels	...	333	666	...	...	<i>Jacquet, Metaux et Corrosion</i> , 14, 1939, 127; 18, 1943, 198.
2.	Ni	...	205	795	...	...	<i>Jacquet, Rev. Metallurgie</i> 37, 1940, 210.
3.	Sn	...	194	806	...	...	<i>Jacquet, Publ. no. 90, Intern. Tin Res. Dev. Council</i> , 1939.
4.	Pb	...	352	628	...	20	<i>Jacquet, Rev. Metall.</i> , 37, 1940, 210.
5.	Sb-Sn alloys	...	200	710	...	90	<i>ibid.</i>
6.	Fe & C steels	...	185	765	...	50	<i>Jacquet & Rocquet, Compt. Rend.</i> , 208, 1939, 1012.
7.	Ni	...	210	...	790	...	<i>Jacquet, Rev. Metall.</i> , 37, 1940, 210.
8.	Cr steels	...	47	...	953	0-15	<i>Jacquet, Compt. Rend.</i> , 227, 1948, 556.
9.	Al	215	...	785	...	...	<i>Jacquet, Compt. Rend.</i> , 205, 1937, 1232.

such as glycerine and ether. The latter category of baths will not be considered here.

Table I gives a few examples of the composition of electrolytes of the first type. Their preparation necessitates a few precautions. Although the addition of acetic acid to perchloric acid at 65% concentration (density 1.59-1.61) does not give rise to any heat, there is a considerable evolution of heat when using the acetic anhydride, as a result of the exothermic reaction:



The mixture should thus be made slowly by adding very small portions, with external cooling sufficiently strong to prevent the temperature from rising above 35° to 40° C. Up to the present the acetic anhydride has been added to the perchloric acid but according to the results of experiments described later it seems that the reverse, that is the addition of the acid to the anhydride, is preferable.

At the time of the preparation, the mixture sometimes exhibits a violet coloration characteristic of the manganese ion (Mn^{VII}), due presumably to a trace of manganese present from the catalyst used in the preparation of the anhydride. This color is always fugitive and is replaced by a brown tint the intensity of which depends upon the maximum temperature reached in the course of the preparation.

The electrolyte being a poor conductor, the current density necessary for polishing (50 to 250 A/ft²) requires a rather high terminal voltage (20 to 50 volts, more rarely about ten volts). The electrolysis is accompanied by a rapid heating of the metal and the liquid surrounding it. In effect, the anode is covered with a viscous layer rich in the products of solution of the metal with a much greater electrical resistance than that of the mass of the bath. It is thus essential that sufficient refrigeration of the polishing cell be used so that the temperature measured at 1 or 2 cm. from the specimen never rises above 30° C.

One will avoid the risk of local overheating of the conducting parts immersed by always making certain of a good contact between the specimen and the wire delivering the current.

The technique of operation for polishing should be devised so that it eliminates all possibilities of short circuit. For the reasons revealed above, attempts should be made to prohibit the presence of complex organic materials in aceto-perchloric mixtures. However, certain investigators have, after the current fashion, used varnish or chlorinated rubber for partial insulation of the anode, as well as electrode supports of polystyrene or ebonite or coatings of polymerizable plastics. It does not appear that these products have given rise to accidents in baths of normal composition maintained below 30° C.

* E. Kahane has recently studied⁴ the thermochemistry of this reaction. The results show that the quantity of heat evolved corresponds to the difference between the heat of hydration of the acetic anhydride and that of the perchloric acid. Thus, all that happens is that the acetic anhydride dehydrates the perchloric acid to finally form a mixture of acetic acid and anhydrous perchloric acid.

The specialists who are currently polishing in aceto-perchloric acid mixtures are sometimes found to operate under conditions which would appear to favor an explosive reaction. We will give a few personal examples. A solution with the composition of Number 7 in Table I has been used for a long time in polishing specimens measuring about 1 dm², in volumes of several liters and at temperatures reaching the boiling point. One of the compositions of Number 6 has been carried at 60-70° C. during the polishing of a specimen of bare steel. Quite often a few sparks are produced above the bath at the moment of the removal of the anode under voltage. In each case these conditions, which might be classified as abnormal, have not caused either explosion or fire.

History of the Accidents with Perchloric-Acid Baths

There have been five cases of accident which have come to our attention up to now.* One of these, consisting of an electrolyte rich in isoamyl alcohol, should be set aside. With the exception of the explosion at Los Angeles, all of these explosions were produced with relatively small volumes of electrolytes.

The author has personally used almost every day for the last ten years, electrolytes containing perchloric acid and acetic acid or anhydride, without having had a single accident. It is the same with a large number of investigators in France and elsewhere. However, others hesitate to use the method or trust it for fear of the explosions they anticipate because of the detestable reputation of perchloric acid. This attitude has found still more reinforcement in the descriptions of the accidents actually occurring. Before discussing them we believe it best to give a few examples, which are impersonal, of industrial or semi-industrial polishing installations which have functioned for a long time without incident, and all containing perchloric acid.

A bath of about twenty liters capacity and of the composition of that of Number 1 in Table I has served to polish aluminum in the laboratory of *Chambéry de la Société Alais-Froges & Camargue*.

At the time of the explosion at Los Angeles it was learned that certain American firms had been using electrolytic polishing for several years in cleaning of small pieces of steel in baths containing thousands of liters. The bath used by one of these firms consisted of one part of 72% perchloric acid and four parts of acetic acid.

An accident in Germany is mentioned in a note of Köster,⁵ which unhappily does not give any detail, neither on the exact composition of the aceto-perchloric mixture nor on the circumstances of the accident. The explosion took place after four hours of electrolysis when the refrigeration was normal and when no organic material was able to come in contact with the bath. Köster also writes that the bath gave signs of sparking from the start, and he supposed that un-

* The author would be grateful to readers of "Metal Finishing" if they would communicate with him with the maximum of details on the description of any explosion of perchloric acid polishing baths which they have been able to observe.

known explosive materials might have been ignited, although tests have shown that the formation of sparks is not necessarily conducive to explosion reactions. In his conclusion Köster counseled strongly against the use of aceto-perchloric electrolytes.

LOS ANGELES ACCIDENT⁶

This occurred on the twentieth of Feb. 1947 in an electroplating factory which was studying the polishing of aluminum on an industrial scale in 800 liters of an electrolyte containing 3 parts of 72% perchloric acid and one part of acetic anhydride. The explosion, extremely violent, completely destroyed the factory of brick construction, leaving in the place of the bath a crater 2.2 meters deep and 6 to 7 meters in diameter; 116 houses in the vicinity, some at fairly great distances, were more or less damaged. This accident cost the lives of 17 people and injured about 150. The destruction was evaluated at about 2 millions of dollars.

The investigating committees established the following points:

- A. The pretended inventor of the process was an adventurer without technical knowledge but who did not appear, however, to ignore the danger of his electrolyte.
- B. The process had been studied since the first of September, 1946. A bath of 120 liters functioned for several months without accident.
- C. An automatic system of refrigeration was provided for, so that the temperature would not rise above 27° C. A short time before the accident this system stopped operation but the electrolysis was nevertheless continued.
- D. The day of the accident the racks for the work, formerly of iron, were replaced by metallic pieces covered with a plastic (cellulose acetobutyrate).

The above results allow confirmation of the fact that the explosion was a result of serious faults in the principles and conduct of the process, faults which would have been evident to a competent technician. At the moment of the accident there was in effect, a combination of three dangerous conditions:

1. Very high concentration of perchloric acid (75% of HClO_4 of density 1.72 when the normal electrolytes contain a maximum of 37% HClO_4 of density 1.61).
2. Excessive heating of the mass of the bath, and still much more in the neighborhood of the electrodes.
3. Presence of organic matter in contact with a hot bath.

One of the chemists charged with the inquiry at Los Angeles had obtained an explosion in the laboratory by adding 1 cc. of this plastic to 1 cc. of a mixture of 2 parts of perchloric acid and 1 part of acetic anhydride and heating progressively.⁷

ANOTHER ACCIDENT IN THE UNITED STATES⁷

An explosion in a polishing bath for tin has been reported (composition of No. 3, Table I) of a capacity of 1000 cc. at the time of the removal of the electrode.

Several experiments prior to this did not give rise to such an incident, even though the conditions were strictly identical. The observers have supposed that the explosion was provoked by a brisk local heating, due to accidental contact of the two electrodes under voltage.

ACCIDENT IN ENGLAND

This did not behave as an explosion but as a violent spattering in the course of the preparation of an aceto-perchloric mixture which was insufficiently refrigerated.

ACCIDENT IN AUSTRALIA⁸

A small aluminum polishing bath caused an explosion in Melbourne. The cause of it was attributed to the presence of an insulant of plastic placed over the surface of the bath and which became impregnated by capillarity with the solution being used. It is also possible that the bath was subject to a partial evaporation of acetic acid, thus causing an enrichment in perchloric acid.

Study of the Explosive Properties of Aceto-Perchloric Mixtures

We have already stated that, as a general rule, an explosive is obtained when a combustible liquid is mixed with an oxidizing liquid in the appropriate proportions. An illustration of such a mixture is illustrated by the panclastites proposed by Turpin in 1882 and which contained nitric oxide, NO_2 (a liquid boiling at 22° C.) mixed with various combustibles (carbon disulfide, petroleum ether, nitrobenzene). These mixtures have explosive properties comparable with nitroglycerine. Like this material they are sensitive to shock and can detonate at a rate of 7,000 M/sec.

With such combustible liquid-combustion supporting liquid mixtures, one generally observes that the explosive properties vary in a continuous manner with the percentage of each constituent. An optimum condition for the manifestation of the most marked explosive properties exists. In withdrawing from this optimum by reducing or increasing the percentage of combustion supporter, the explosive properties are subject to an attenuation and finally become non-existent. Experience has shown that the most explosive composition is always very near the proportion which is termed complete combustion, and which contains the necessary amount of oxygen for just complete combustion, or complete transformation of the carbon to CO_2 , the hydrogen to water, the chlorine to HCl (nitrogen is evolved in the free state). Nevertheless there is a small discrepancy which can be explained by the theory of explosives.

By decreasing the proportion of the combustion supporter from the optimum, one should obtain mixtures of ever decreasing explosive activity, and finally reach a point below which the mixture is no longer explosive. In the same way at very high concentrations of the combustion supporting material the mixtures will not detonate. Figure 1, in which the properties of the explosive (power and sensitivity) are plotted

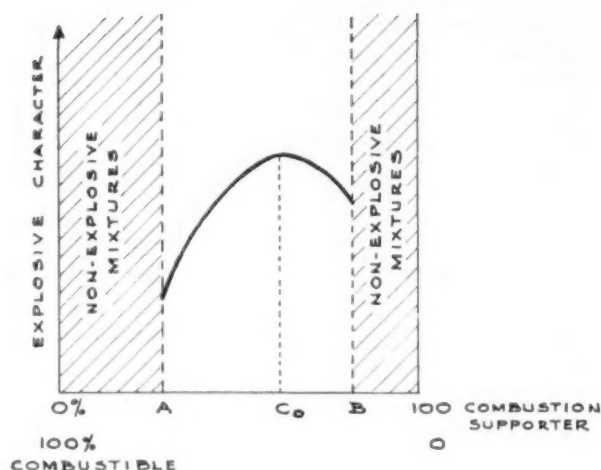


Fig. 1

as a function of the percentage composition illustrates this fundamental concept.

In this manner one may predict what mixture of perchloric acid (combustion supporter) with acetic acid (combustible) should give rise to explosive liquids. The mixture for complete combustion corresponds to the equation:



which liberates energy equivalent to 1250 K joules per Kg., a value between that for nitrocellulose and nitroglycerine, which is characteristic of a powerful explosive. The temperature of the explosion will be of the order of 2500° C., and it is probable that the detonation would attain a rate between 5000 and 7000 M/sec.

We have seen, however, that the aceto-perchloric polishing baths are made by using perchloric acid which is not anhydrous but has a concentration between 65 and 72%. Because of this, in spite of the replacement of acetic acid by the anhydride, the final mixture must contain a certain amount of water. Finally and most important, the practical electropolishing mixtures are rather far from the optimum, or "complete combustion" mixture.

Thus the electrolytes for polishing are very fortunately sufficiently far from presenting the characteristics of explosivity of the mixture shown in equation 1, which might be compared with nitroglycerine. Although to an explosive engineer these baths are only mild explosives, they are still eventually apt to cause accidents. During the last war the Germans had considered finishing certain pieces of arms by electrolytic polishing in perchloric-acetic baths. In view of the wiring of important installations they performed a study of the explosive properties of the mixtures.⁹ Their results are not known to us in detail and we only know that they concluded that there was no danger if certain conditions were realized (refrigeration, absence of organic materials, no flame).

The experimental study of the eventual dangers of polishing electrolytes based on perchloric acid was recently made in France by *L. Medard*, Ingenieur en Chef des Poudres, and *R. Sartorius*, Ingenieur des Poudres.¹⁰ Their observations are to be summarized and discussed.

The investigation of *Medard* and *Sartorius* aimed

at ascertaining the explosive properties of mixtures of perchloric acid and acetic anhydride, and to define insofar as possible the region of concentration of each constituent in the mixture which was dangerous.

All of the experiments were carried out with acetic anhydride titrating practically 100% (density 1.030 at room temperature) and 62.7% perchloric acid (density 1.590 at room temperature).

PREPARATION OF THE MIXTURES

In general, the literature on electrolytic polishing specifies the preparation of the baths by slowly adding, in small portions, the acetic anhydride to the perchloric acid. The mixture which corresponds to the complete transformation of the water in the perchloric acid solution into acetic acid by means of the acetic anhydride is obtained with:

24.3 volumes of 62.7% perchloric acid
75.7 volumes of acetic anhydride

When the anhydride is added to the perchloric acid it is accompanied by a sputtering noise, the solution becomes hot, and the anhydride dissolves instantaneously, whereas it only dissolves very slowly in pure water. Nevertheless, one should provide for vigorous agitation, for the lighter anhydride has a tendency to float on the surface. The vessel is externally refrigerated so that the temperature of the mixture does not exceed 50° C.

Mixtures of all proportions may be thus obtained without accident. As the proportion of the acetic anhydride increases, the violence of the reaction is minimized and the sputtering noise is observed to be less and less intense. The heating becomes negligible when the quantity of acetic anhydride is greater than 76.8%.

If the liquid is constantly maintained below 40° C., the mixture obtained is colorless: if not, it is more or less strongly colored greenish yellow, a color which is presumably due to the presence of chlorine oxide. The aceto-perchloric solutions thus prepared do not appear to change on storage for several days.

Given, as we will show later, that a critical content of perchloric acid exists, for which the mixture with the anhydride is sensitive to shock, it is proper to consider the preparation of the baths by adding the perchloric acid to the acetic anhydride. The addition is made entirely in small portions and under refrigeration. One always obtains a sputtering noise when the acid falls into the anhydride, then it is dissolved instantly. The heating is considerable until the content of acid reaches 23.2% by volume. After this no reaction is observed.

The greater evolution of heat evolved in adding the perchloric acid to the anhydride recalls that taking place with mixtures of sulfuric acid and water, and is explained by the fact that 1 cc. of anhydride falling into a sufficient quantity of perchloric acid produces one third as much heating as 1 cc. of perchloric acid dropping into anhydride. It will also be noticed that mixing the constituents in the inverse order from that generally indicated always gives a greenish yellow solution regardless of the precautions taken for refrigeration.

We should examine the case where the acid and the anhydride are mixed rapidly. The experiments were made by emptying the contents of one container into another by means of an apparatus electrically controlled from a distance, observations being made from a shelter and with the aid of a mirror.

- a) By pouring 30 cc. of acetic anhydride into 70 cc. of perchloric acid the reaction was vigorous, with the evolution of white fumes for a few seconds.
- b) In the preceding mixture, which corresponds to the composition sensitive to shock, by adding another 30 cc. of anhydride another vigorous reaction with the evolution of fumes is observed.
- c) By reversing the operation and rapidly adding 50 cc. of perchloric acid to 150 cc. of anhydride, the reaction is more vigorous than previously. There is a spattering of the liquid and evolution of vapor for about ten seconds.

In conclusion, in each of these attempts the mixture did not explode. The most serious inconvenience to fear when the two liquids are rapidly mixed seems to be the possibility that the operator might be splattered with solutions of hot acid. From this point of view the addition of the acid to the anhydride appears to be the less dangerous. Let us finally note that the essence of these results has been confirmed by *Bolle* at Centre du Bouchet: he was not successful in obtaining an explosion in the preparation of aceto-perchloric mixtures even by the rapid addition of one reagent to another.

Sensitivity to Priming

The determination of what one might call the "explosibility" is done by trying the sensitivity to a primer. The smaller the amount of primer used, the more sensitive is the explosive. The authors used primers of mercury fulminate of 0.3, 0.6, 1, and 2 grams, detonators of 2g. strength (equivalent to 3g. of fulminate), *Briska* detonators (equivalent to 4 or 5g. of fulminate), and finally boosters of compressed P.E.T.N. (pentaerythritol tetranitrate) of 10 to 50 gms.

The aceto-perchloric mixture is contained in a small aluminum tube placed on a horizontal plate of lead and against a similar vertical plate. The violence of the explosion is determined by the diameter of the imprint in the lead under the tube and by the extent of the imprint on the lateral lead. One may thus study the different compositions of the perchloric acid-acetic anhydride mixtures as well as the influence of the addition of small quantities of water.

The results show that the mixture corresponding to the "complete combustion" (reaction 1) and which contains 68 parts by volume of perchloric acid and 32 parts of anhydride is the most sensitive to the primer: 0.6 g. of fulminate caused its detonation. The sensitivity diminished very quickly as the proportion of acetic anhydride increased: when the quantity of perchloric acid is less than 57% (by volume) the mixtures no longer detonate. In particular the

"anhydrous" mixture containing the necessary amount of acetic anhydride to completely remove the water in the perchloric acid (24.3 volumes of perchloric acid-75.7 of acetic anhydride) will not detonate even with a relay of 50 g. of P.E.T.N.

Addition of water to the mixtures sensitive to detonation reduces their sensitivity, and when this quantity of water corresponds to perchloric acid of 1.50 density, an explosion cannot be produced even if the composition in acid and anhydride corresponds to the "complete combustion" mixture.

Study of the Complete Combustion Mixture

Medard and *Sartorius* measured the sensitivity to shock and the speed of detonation of the mixture corresponding to "complete combustion" which contain by volume 68 parts of perchloric acid of density 1.59 and 32 parts of acetic anhydride.

For sensitivity to shock a drop of liquid weighing approximately 34 mg. is placed in a small metal capsule. A ram of 1 kg. mass falling through 1.40 meters supplies the shock. In a series of 100 tries, 50 explosions were observed. Under the same conditions an explosive such as nitroglycerine only needs a height of drop of 0.80 meters and the explosions then are very noisy, not leaving any residue in the capsule, while with the aceto-perchloric mixtures certain blows giving an explosive noise leave a liquid residue. These results show that the mixture is rather sensitive to shock but this only starts a local decomposition which is not transmitted through all of the liquid. It is important to emphasize that, with a large weight of 30 kg. falling through 3.5 meters on a small flask of 5 cc. of the mixture, neither fumes nor noise of the explosion are observed.

The measure of the velocity of detonation (method of *Dautriche*¹¹) gives rather variable results, for this rate decreases with the distance from the primed end. In metal tubes the detonation stops according to a line function of the diameter of the tube and its thickness. Thus the line is 20 cm. for a steel tube 4 mm. thick and 18 mm. in diameter. Given that the conditions of the test should favor detonation, one may conclude from these results that the mixture corresponding to "complete combustion" only has a poor tendency to detonate.

Attempts at Explosion by Ignition or by Heating

We have already shown that a rapid mixing of the two constituents of the aceto-perchloric baths causes a considerable elevation of temperature but does not lead to an explosion. *Medard* and *Sartorius* have tried the action of a direct flame or of a wire held at a high temperature by an electric current. For example, 50 cc. of liquids of various compositions were brought into contact with a flame. It was observed that the mixtures richest in acetic anhydride burned easily when they reached the boiling point but upon increasing the concentration of perchloric acid the ignition became more and more difficult: the mixture of equation 1, corresponding to "complete combustion" did not burn, even though most sensitive to shock. However, at high temperatures, such as encountered

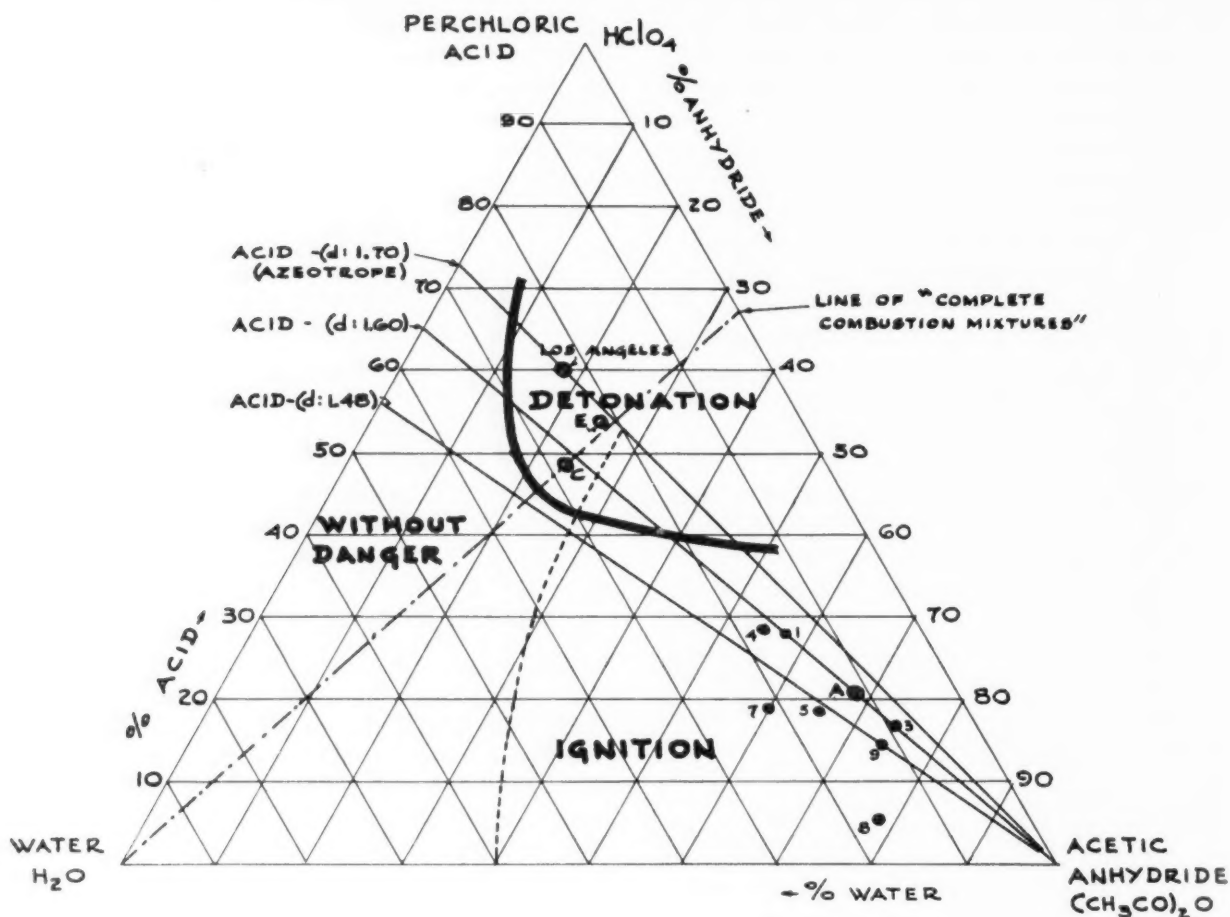


Fig. II

in a fire, the aceto-perchloric baths are always very dangerous.

Attempts to ignite 10 cc. of the mixtures contained in a small tube by means of an electrically heated red hot wire gave negative results: regardless of the position of the wire, whether in the vapor or in the liquid, there was no explosion. The red hot wire was able to burn the vapors which were liberated from heated mixtures containing more than 60% of the anhydride but there never was an explosion. These results tend to prove that a short circuit in the liquid or in the vapor of a cell ought not cause an explosion. It would not be the same with explosive liquids such as methyl nitrate, in which case heating with a red hot wire causes a violent explosion.*

Complimentary Tests

Apart from the research of *Medard and Sartorius*, other tests have been made in France by *Demay* at the Laboratoire de la Société Française des Munitions and by *Bolle* at the Centre d'Etudes du Bouchet.

Demay has given particular attention to two polishing electrolytes, one relatively concentrated (37% by volume) and the other very dilute (5.3% by volume) in perchloric acid content. Each of these mixtures also contain a small quantity of iron and aluminum ions in solution. Attempts at explosion by means of the

* This point should be emphasized, for the literature describes polishing electrolytes composed of nitric acid and methyl alcohol.

classic method of the lead block on 5 cc. portions of each mixture primed with fulminate of mercury (2 grams), did not show any difference in comparison with similar attempts made under the same conditions on distilled water.

The experiments of *Bolle* consisted of the examination of the effect of the temperature and various additions of simple or complex organic materials on aceto-perchloric mixtures having the composition of polishing baths. In each case there was no explosion. Nevertheless the addition of fine shavings of wood to a solution heated to 60°C. caused an ignition which could degenerate to a fire in volumes of solution larger than the 2 or 3 cc. used in these trials.

Conclusions

From the point of view of danger of polishing baths containing perchloric acid and acetic anhydride, the experimental results now known allow important conclusions to be drawn.

1. In the case of perchloric acid of density 1.60 and pure acetic anhydride the mixture of most marked explosive character is that containing 68 volumes of acid and 32 volumes of anhydride. In comparison with practical explosives this is mediocre at best.
2. Mixtures containing less than 55% by volume of perchloric acid are incapable of detonation, which is the case with all of the polishing baths which we have recommended. Thus the richest bath in

perchloric acid, Number 1 in Table 1, contains only 37 volumes of 65% perchloric acid, 63 volumes of acetic anhydride and 8 volumes of water.

3. Not presenting any explosive properties are the mixtures obtained with perchloric acid of density less than 1.50. For example, the mixture corresponding to "complete combustion" prepared with acid of density 1.60 detonates with priming but is no longer explosive upon the addition of 13% water. These mixtures are all the less apt to explode when made with less concentrated acid and if the ratio of acetic anhydride to acid is higher.

These conclusions are easier to read on the triangular diagram, Figure 2, of which the apices correspond respectively to 100% perchloric acid, acetic anhydride, and water (water brought in by the perchloric acid without consideration of the more or less partial elimination caused by the presence of acetic anhydride). The mixtures susceptible to detonation are situated in the shaded region of the diagram bound by the arc of the curve. This region includes the "complete combustion" mixture represented by point C, and also the bath which exploded in Los Angeles in Feb., 1947, and which contained 75 volumes of 72% perchloric acid and 25 parts of acetic anhydride. Now it may be concluded from the diagram that the mixture of "complete combustion" contains 66 volumes of 72% acid and 34 volumes of anhydride, which proportions are very little different than those of the Los Angeles mixture. The point E which corresponds to a mixture of 2 volumes of 72% perchloric acid and one volume of anhydride (which exploded in laboratory trials at 60°C in the presence of cellulose aceto butyrate) has precisely the composition of the "complete combustion" mixture.

On this diagram it may also be seen that all of the points corresponding to the composition of normal polishing baths are situated rather far from the dangerous zone, as well as from the mixture called "anhydrous" (represented by point A), or that in which all of the water introduced by the perchloric acid of density 1.60 is totally combined by the acetic anhydride.

4. A red hot wire in the solution or in the vapor above it does not cause an explosion, but a mixture rich in anhydride may burn if carried to a high enough temperature and at contact with a flame. It might be feared that the burning of a large mass might end in an explosion.

All of these results concern pure aceto-perchloric mixtures, or those not containing other constituents. A priori it does not appear that the presence of metallic ions, as is always the case with polishing baths, would augment the danger; this is rather the reverse of the effect that they ought to produce. The presence of small traces of organic materials is no more dangerous

but it would not be the same if a massive quantity of organic material came in contact with the mixture, especially if hot. In particular, porous organic materials which may become impregnated with the liquid are not recommended for mountings or apparatus for electrolytic polishing. If insulants are absolutely necessary, they should be chosen from materials such as Ebonite or chlorinated rubber in preference to plastics based upon cellulose esters.

In summary, if the specified precautions are respected (adequate composition of the mixtures, absence of organic materials in contact with the bath or its vapors, sufficient refrigeration to avoid the distillation of acetic acid which leads to an enrichment of the bath in HClO_4 , removal of the installation from all flame) one need not fear an explosion in the practice of electrolytic polishing using acetoperchloric baths.

Acknowledgments

The author wishes to thank all of the explosive specialists who are interested in problems of polishing baths based on perchloric acid, particularly Mr. *Muraour*, Ingenieur General des Poudres; Mr. *L. Medard*, Director of the Commission des Substances Explosives; Mr. *R. Sartorius*, Ingenieur des Poudres; Captain *Bolle*, of the Centre d'Etudes du Bouchet; and Mr. *Demay*, Technical Director of the Société Française des Munitions. The author also thanks Mr. *E. Kahane*, director of the Laboratoire de Microchimie Organique du Centre National de la Recherche Scientifique, a specialist in the chemistry of perchloric acid for his aid and counsel.

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Shop Problems

Abrasive Methods—Surface Treatments—Control
Electroplating—Cleaning—Pickling—Testing

METAL FINISHING publishes, each month, a portion of the inquiries answered as a service to subscribers. If any reader disagrees with the answers or knows of better or more information on the problem discussed, the information will be gratefully received and the sender's name will be kept confidential, if desired.

Anodes for Gold Plating

Question: In gold plating from a standard gold cyanide bath we have been using 18-8 stainless steel anodes, but find that they rust seriously, with nickel and chrome going into the solution. We have also tried small carbon anodes and have also tried platinum plated stainless steel, but the platinum had a tendency to peel off stainless steel. What can you recommend as a suitable anode material. The anodes are $\frac{1}{8}$ " in diameter.

K. H. G.

Answer: Stainless steel anodes are widely used in gold plating without the rusting difficulties which you seem to have encountered. Perhaps you have gotten something other than 18-8 stainless steel, which could cause this trouble. About the only other cause for this severe anode corrosion could be a high chloride contamination in the bath.

Other materials which can be used would be platinum gauze rolled into $\frac{1}{8}$ " diameter cylinders, gold wire, or gold plated stainless steel wire. You can make either the gold or platinum adhere to the stainless wire if the wire is first given a "strike" plate in a high chloride nickel plating bath, followed by the regular plating procedure for gold or platinum.

Degreasing Light Parts

Question: In buffing thin aluminum molding strips we are getting a black mixture on the underside of the molding where it is not buffed, which appears to be carbonized grease and aluminum particles. Vapor degreasing does not seem to remove this material and we would appreciate your recom-

mending a method to remove this contamination.

W. C. R.

Answer: There are several possible solutions to your difficulties. It is possible that the parts are so thin and light that the condensation period in the trichlorethylene vapor is too short to permit adequate removal of the contamination. Heavier work loads in each basket of work being degreased will help overcome this difficulty. It is possible that you should also be using another solvent, perchlorethylene, which, having a higher boiling point, will give a longer condensation period and thus do a better cleaning job. Your equipment manufacturer should be contacted before making any change in solvent. A second cause of your trouble may be that the parts are being stacked in such a manner as to prevent the vapors from reaching the contamination and running off of the parts after condensation. Attention to the method of stacking the parts would clear this up. A third possibility is to use a boiling solvent stage in the degreaser, followed by a cool solvent dip and a vapor phase treatment. Immersion in the boiling solvent is effective in loosening the more stubborn types of buffing composition contaminations. It is also possible to have a spray attachment put on your present equipment which is also effective in removing contamination which clings to the parts.

There is no reason why this mixture should not be removable in a degreasing process, unless the black coloration is really a surface scale or product of a reaction between the aluminum and other compounds. If the latter is the case, then a degreasing treatment fol-

lowed by a pickling cycle will leave the parts in a clean condition.

Removing Copper from Heat Treated Steels

Question: Can you advise us of a method for removing copper which has been plated on dies to prevent oxidation during heat treatment? After heat treatment we want to remove this copper and leave a bright, smooth surface on the die.

B. T. L.

Answer: Copper plated onto steels for protection during heat treatment is usually more or less completely converted to oxide which can be removed in one of the following pickling solutions, often called "scaling" pickles:

1. Sulfuric acid 1 pt/gal
Sodium dichromate 2-4 oz/gal
Temperature 175°F
2. Sulfuric acid 13 oz/gal
Ferric sulfate 13 oz/gal
Temperature 160°F

If a light film of copper remains on the parts after either of the above treatments the parts can be immersed in a 4 oz/gal solution of sodium cyanide to completely remove this copper film.

Antique Gold Finishes

Question: We are enclosing a sample of an antique gold finish which we would like to reproduce and would appreciate any suggestions you can make for doing this.

E. E. K.

Answer: The following procedure can be used in producing an antique or "oxidized" gold finish similar to the one on the sample which you forwarded.

1. Deposit a light copper plate on the parts.
2. Dip in a sulfide bath to oxidize (blacken) the copper deposit.
3. Make cathodic for 5 to 10 seconds in a 3 oz/gal solution of sodium carbonate. This will form a black smut on the parts. The high spots are now relieved by a light buffing operation. After rinsing the parts are then plated

in the desired gold solution, following which they should be rinsed, dried, and coated with clear lacquer.

Recovering Gold and Silver From Highly Acid Baths

Question: In stripping reject mirrors we accumulate a considerable quantity of highly acid solutions (aqua regia) containing gold and silver salts. Can you suggest an economical way to recover these metals from such a solution?

W. A. H.

Answer: The recovery method would depend on the form in which you wanted the recovered metals. Assuming that you are just interested in the reclaim value, the following method could be used to recover the gold and silver separately.

The bath is nearly neutralized with caustic soda, then enough sodium chloride solution used to precipitate all silver as silver chloride. After filtering off the silver chloride the solution is made completely neutral with caustic soda, then enough sodium cyanide added to give a clear solution. The gold can then be plated out using a stainless steel cathode and stainless steel anodes. The metallic gold deposit can easily be stripped from a stainless steel cathode.

The silver chloride can be sold to a refinery for further processing. If the original acid bath contained metals other than silver and gold, the gold deposit obtained would be impure and would have to be refined to obtain a pure grade of metal.

Plating Zinc Die Castings

Question: After following the usual cleaning cycle for zinc die castings I don't seem to get the original bright finish on the parts just before plating. Can you tell me how to accomplish this?

W. L. J.

Answer: It is not necessary to have the highest lustre on zinc die cast parts prior to the plating operations. All that is required is a smoothly buffed finish which is then subject to the usual cleaning cycle. During the cleaning cycle the original bright lustre of the surface is destroyed, but if the cleaning cycle is properly carried out this slightly darkened surface will not affect the quality or adhesion of any subsequent plating.

Converting Bright Nickel Baths

Question: We have a set up which was used for bright nickel plating, which we have purchased second hand. We understand that the solution previously used in this equipment was a different type of bright nickel than the one we are planning to use. Would this equipment be suitable, or would we have to make some changes in it?

T. F.

Answer: The safest procedure for you to follow would be to call in a service engineer from the company from which you intend to purchase the bright nickel formula and ask for his recommendations. It may be that you will have to have different tank linings, different heating coils, different heat exchangers, different agitating means, different filter set up, etc., as all proprietary bright nickel baths must be operated under fairly rigid conditions in order to obtain best results.

Chrome Plating Over Silver

Question: We would like to know if it is possible to chrome plate directly over silver plate and whether or not the method is patented. Any information you can give us on this would be greatly appreciated.

C. M.

Answer: There is no reason why you can not chrome plate directly on to silver plate, provided the silver plating is properly cleaned. If the silver plating is buffed, a short reverse current treatment in a 4 oz/gal sodium cyanide bath followed by rinsing and dipping in a weak sulfuric acid dip will enable you to successfully chrome plate.

If you are chrome plating immediately after silver plating with no buffing operations in between, the reverse current cyanide treatment may not be necessary, but would be advisable.

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PATENTS

Plating Nickel on Aluminum Alloys

U. S. Patent 2,473,163. E. M. McCoy.

In a process for plating nickel upon a metal piece selected from a group consisting of aluminum and aluminum alloys, the steps of dipping said piece in ammonium bifluoride water solution, in which the ammonium bifluoride is from 5 to 20% by weight, anodically oxidizing the piece in an aqueous solution of orthophosphoric acid in which the acid is from 5 to 20% by volume at a potential of at least four volts to form an adherent conductive coating on the piece, and electroplating nickel thereon in a bath having a pH below six.

Phosphating Treatment for Metals

U. S. Patent 2,473,614. E. Snyder, assignor to American Chemical Paint Co.

A material for use in treating a surface of metal from the group consisting of iron, zinc, aluminum and of iron-base, zinc-base and aluminum-base alloys, the principal active ingredients of which material consist of an intimate admixture of degreas and orthophosphoric acid together with a liquid vehicle for said admixture, the quantity of orthophosphoric acid being from 1 to 15% by weight of the degreas and the quantity of the vehicle being sufficient to obtain intimate incorporation of the degreas with the acid.

Electronic Controls for Strip Plating Machines

U. S. Patent 2,473,918. G. E. Stoltz & J. E. Erbe, assignors to Westinghouse Electric Corp.

In a control system for an electrolytic process employing a plurality of electrolytic baths, variable speed means for causing a length of material which is to be electrolytically treated to move through the baths, means for supplying current to the electrolytic baths, separate means for varying the current supplied to the separate baths, regulator means jointly responsive to the current flow in the separate baths, means for selectively connecting said regulator means in controlling relation

with one of said current varying means to maintain a predetermined ratio between the currents supplied to the separate baths, and means responsive to the speed of travel of the strip and the current supplied to at least one of the baths for so controlling said variable speed means as to maintain a predetermined relation between the speed of travel of the length of material through the baths and the current flow in the baths.

Metallizing Non-Conductors

U. S. Patent 2,474,502. C. T. Suchy.

Process for the metallization of electrically non-conductive fabrics, electrically non-conductive fibrous materials, and electrically non-conductive porous materials, which process comprises rendering the internal structure of the material electrically conductive by immersing the material in a colloidal silver solution to which is added a reducing solution to deposit metallic silver within the internal structure of the material being treated; thoroughly drying the material, and then brushing the surface thereof to rid the same of any metallic silver deposited thereon and restore the surface of the material to its initial non-conductive state; then subjecting the material to electro-deposition in an electrolytic bath, drying to rid the material of all moisture, and finally polishing to close the pores of the electro-deposited metal.

Tarnish and Corrosion Proof Wrapping

U. S. Patent 2,475,186. J. Kamlet, assignor to Boyle-Midway, Inc.

The method of protecting metallic surfaces against tarnishing and corrosion which comprises confining the metal surfaces together with circumambient atmosphere and a sublimable corrosion inhibitor in an isolated space, the effective portion of said corrosion inhibitor consisting essentially of a minor amount of an organic amine having a vapor pressure between about 7.5 and about 60 millimeters of mercury at 20° C. homogeneously distributed throughout the mass of a major amount of a non-corroding, solid, sublimable organic material having a melting point of at least 50° C. and a vapor pressure of at least 0.15 millimeter of mercury at 35° C., whereby the vapors from the corrosion inhibitor diffuse through the circumambient atmosphere and con-

tact the metallic surfaces to be protected.

Electropolishing Internal Surfaces of Hollow Valves

U. S. Patent 2,475,586. K. M. Bartlett, assignor to Thompson Products, Inc.

The method of electropolishing the inner surface of the stem of a hollow valve which comprises positioning a hollow electrode in said stem, flowing an electropolishing electrolyte through said hollow electrode into said valve while permitting the excess of said electrolyte to overflow from said valve, making said inner stem surface the anode and said electrode the cathode, and while continuing said electrolyte flow passing an electric current from said anode through said electrolyte to said electrode of sufficient current density and for a sufficient period of time to effect a polishing of said inner stem surface and to render said inner stem surface free from any amorphous layer.

Bonding Metal Carbonyl Deposits

U. S. Patent 2,475,601. A. O. Fink, assignor to Commonwealth Engineering Co.

In a process of depositing metal on a copper base material by the decomposition of metal carbonyl, the steps of exposing the copper base to a carbon dioxide atmosphere containing 1.4% by volume of a metal carbonyl from the group consisting of nickel, chromium, iron, tungsten, cobalt, and molybdenum for a period of time of approximately two minutes while said copper base material is heated to approximately 375° F., said gas having a rate of flow approximately 4l. per minute at a temperature of 78° F. and 125 mm. Hg; of then heating said copper base with said metal film thereon to approximately 800° F. for about 15 minutes in an atmosphere of natural gas and then exposing said coated article to the same metal carbonyl containing gas as the under coat until the coating of the desired thickness has been obtained.

Acid Copper Plating Bath

U. S. Patent 2,475,974. A. M. Max, assignor to Radio Corp. of America.

An acid copper plating solution consisting essentially of approximately 25 ounces to 32 ounces of copper sulfate, approximately 3 ounces to 10 ounces

of sulfuric acid, and an addition agent comprising approximately 0.7 ounce to 1 ounce of triethanolamine per gallon of plating solution.

Blackening Copper Alloys by Immersion

U. S. Patent 2,475,981. I. L. Newell, assignor to Heatbath Corp.

The process of blackening copper and its alloys in which the metal is immersed in a solution consisting of a water solution of a water soluble salt of an aryl sulphone monochloramide made alkaline with a strong water soluble fixed alkali, said solution being heated to a temperature between 175° F. and boiling and the metal held in said solution for a sufficient time to produce the desired depth of black.

Manufacture of Selenium Rectifiers

U. S. Patent 2,476,042. C. W. Hewlett, assignor to General Electric Co.

A selenium rectifier cell which is capable of rectifying alternating current in excess of about 50 volts which consists of a base electrode, a plurality of selenium films superimposed thereon by deposition in vitreous form and intermediate conversion by heat treatment to crystalline form, each said film having a thickness of about one-half mil and the intermediate films being sufficiently surface-oxidized to have individually a rectifying characteristic of about ten volts, the uppermost film being provided with a blocking layer and having a higher rectifying characteristic, and a counterelectrode applied upon said latter film.

Cleaning Aluminum for Spot Welding

U. S. Patent 2,477,181. E. R. Holman, assignor to Turco Products, Inc.

A method for cleaning the surface of aluminum articles which comprises immersing successive aluminum articles in a cold aqueous phosphoric acid bath having a pH below about 3 and an initial concentration of about 0.01% to 2.0% w. of a substance capable of yielding a halide radical, withdrawing the cleaned articles from the bath in about 20 minutes to about 30 seconds varying inversely with the concentration of said substance, and adding sufficient of said substance to the bath from time to time so as to maintain its concentration approximately within this range.

Chromated Protein Films on Zinc Alloys

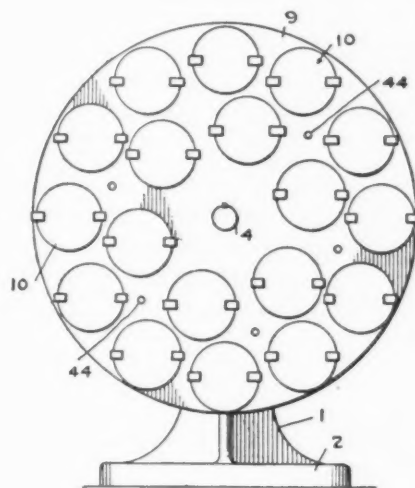
U. S. Patent 2,476,957. A. Brenner & R. Seegmiller & G. E. Riddell.

As an article of manufacture, zinc in commercial form, a film surrounding and encasing said zinc, said film consisting of a dichromate of a metal yielding weak bases, dispersed in a hardened normally water soluble protein.

Tumbling Machine

U. S. Patent 2,476,078. E. B. Banks.

A tumbling apparatus including a vessel carrier rotatable about a substantially horizontal axis, means supporting the vessel carrier for rotation, a plurality of tumbling vessels, means



individually and removably mounting the vessels on the carrier at places located different distances radially from its axis of rotation, and means to rotate the vessel carrier.

Removing Lead and Bismuth from Polonium Plated Coatings

U. S. Patent 2,476,823. T. A. O'Neil, assignor to Firestone Tire and Rubber Co.

The method of removing surface impurities including lead and bismuth compounds from polonium-plated metal which comprises treating the plated metal at room temperature with an aqueous solution containing ammonium hydroxide and ammonium persulfate for a length of time not over fifteen minutes.

Phosphating Stainless Steel

U. S. Patent 2,476,345. A. Zavarella.

The method of treating a stainless steel piece of metal to resist abrasive

wear consisting of, first case hardening the exterior surface of said piece, next mechanically processing by cold working whereby said exterior surface is homogenized, uniformly stressed and roughened, then chemically activating said roughened surface with phosphoric acid, and finally subjecting said exterior surface to a manganese base phosphate bath to provide a non-lustrous, non-galling exterior surface which is resistant to abrasive wear.

Activated Zinc Dust for Metal Precipitation

U. S. Patent 2,477,443. D. J. A. Dahlgren, L. G. Hendrickson, & D. L. Griffith, assignors to Hudson Bay Mining and Smelting Co., Ltd.

The process of precipitating a precious metal from a pregnant cyanide solution, which comprises subjecting zinc dust to treatment in a solution of a water soluble salt of copper and a water soluble salt of antimony in proportions of about 300 parts of zinc dust to every 150 parts of copper and 7 parts of antimony contained in the solution, and introducing the zinc dust so treated into the pregnant cyanide solution.

Belt Grinding and Polishing Machine

U. S. Patent 2,477,358. J. M. Adams.

In a grinding and polishing machine, a base, spaced standards rising from the base, a shaft journaled in each of said standards, a belt pulley keyed to each of said shafts, an endless abrasive belt trained over said belt pulleys, one of said shafts being driven for driving the endless abrasive belt, a work support attached to and rising from said base and including a platform or table located between the upper and lower flights of said abrasive belt for supporting a piece of work to be engaged by the inner side of the upper flight of the abrasive belt, said work support being adjustable for varying the elevation of said platform or table top to move it toward or away from the upper flight of the abrasive belt and for tilting said table top in a direction lengthwise of the belt, and adjustable means for tilting one of said belt pulleys for canting the belt flights relatively to the table top.

DECORATIVE NICKEL AND CHROMIUM PLATING ON ZINC-BASE DIE-CASTINGS

A Comparison of Plating Thickness Specifications of Various Services, Societies, and Industrial Firms

AMERICAN SOCIETY FOR TESTING

MATERIALS

Specification B145-45T

Minimum thickness on significant surfaces—

	Copper + Nickel	Copper	Final Nickel	Chromium
Type FZ	.00125"	.0004"	.0005"	.00001"
Type KZ	.00075"	.0003"	.0003"	.00001"
Type QZ	.0005"	.0002"	.0003"	.00001"

Notes—

Copper undercoats may be omitted from Types FZ and KZ coatings, in which case the nickel thickness shall be that specified for "Copper + Nickel".

For Type QZ coatings, copper undercoats are optional, the nickel thickness in either case being that specified under "Final nickel".

Coatings shall withstand a salt spray test of 48, 32, and 16 hrs. for Types FZ, KZ, QZ respectively.

ARMY-NAVY AERONAUTICAL SPECIFICATIONS

Specifications AN-P-34 and AN-P-39

Minimum thickness on significant surfaces—

Type 1 (Decorative)	Final Nickel	.0005"
	Chromium	.00002"

Notes—

No requirements for preliminary copper deposits, either as a "strike" or in heavier deposits. Presumably copper may be used as a preliminary coating, provided final nickel thickness conforms to above.

Salt spray resistance—48 hours minimum.

Microscopic method for checking thickness is standard. Magnetic and spot tests may be used.

Significant surfaces are those touched by a 3/4" dia. ball.

GENERAL MOTORS CORPORATION

Specification 4251-M

Minimum thickness on significant surfaces—

	Copper + Nickel	Copper	Final Nickel	Chromium
Code 150	.0015"	.0005"	.0005"	.00001"
100	.001"	.0003"	.0003"	.00001"
75	.00075"	.0002"	.0002"	.00001"
20	.0002"	(note)	.0002"	.00001"

Notes—

For Code 20, copper undercoats are optional, but if used, must be at least .0001".

Plated parts must withstand a salt spray test of 48, 32, 24, and 4 hours for Code 150, 100, 75, and 20 respectively, without showing more than minor pinholes (1 spot < 1/16"/sq. in.)

NAVY DEPARTMENT

Specification 46-P-4 Type 1

Minimum thickness on significant surfaces—

	Indoor Service	Outdoor Service
Nickel + Copper	.00075"	.002"
Final Nickel	.0004"	.001"
Chromium	.00002"	.00002"

Notes—

In outdoor service coatings, if copper is used in thicknesses over .0001" the minimum thickness shall be .00075".

Significant surfaces are those touched by a 3/4" diameter ball.

Spot test used to check chrome thickness. Other plating checked by microscopic method.

PACKARD MOTOR CAR COMPANY

Specifications 1406-B, D, E

Minimum thickness on significant surfaces—

	Copper + Nickel	Copper	Final Nickel	Chromium
Extreme service	.00125"	.0004"	.0006"	.00001"
Exterior use	.0008"	.0003"	.0005"	.00001"
Interior use	.0005"	.0002"	.0003"	.00001"

Notes—

Plated parts shall withstand a salt spray test of 48, 32, and 16 hours for extreme, exterior, and interior use respectively.

Undercoats of copper are required on all the above classes of use.

FORD MOTOR COMPANY

Specification P-40

Minimum thickness on significant surfaces—

	Copper + Nickel	Copper	Final Nickel	Chromium
Class F (Light duty)	.0005"	.00015"	.00025"	.00001"
Class G (Moderate duty)	.0007"	.0002"	.0004"	.00001"
Class J (Heavy duty)	.0012"	.0002"	.0008"	.00001"

Notes—

Plated parts shall withstand a salt spray test of 25, 50, and 100 hours respectively.

Salt spray failure is indicated when parts show more than 6 corrosion spots per square foot, or any single corrosion spot larger than 1/16" diam. on a significant surface.

All-Purpose Iridite

Allied Research Products, Inc., Dept.
MF, 4004 E. Monument St., Baltimore,
Md.

A new, all-purpose Iridite has been announced to the metal finishing market by this firm. Named Iridite No. 8—HueBrite, this newest addition to the line of Iridite finishes is another step in the manufacturer's program of developing a wide range of Iridites for any corrosion or painting problem in finishing zinc, cadmium, copper, brass, bronze and aluminum.

Iridite No. 8 is claimed to be extremely flexible from an application standpoint. It can be applied to plated, galvanized or die cast parts—produces an iridescent yellow finish in its original reaction which can be varied in color by changing the concentration of the operating solution and/or incorporating a bleaching step to obtain a clear, bluish, bright finish. The concentrate may be successfully operated at dilutions as high as 1-50, Iridite and water.

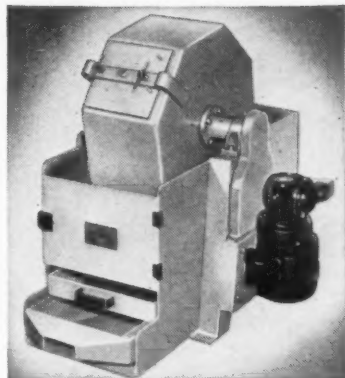
From an operating standpoint, the new finish is said to offer a relatively high coverage per gallon, ease of control and the ability to withstand any harmful effects of a hot rinse. In performance, Iridite No. 8 provides good resistance to corrosion and strong paint base characteristics, according to the firm.

Small-Lot Variable Speed Tumbling Barrels

Belke Mfg. Co., 941-51 N. Cicero
Ave., Chicago 51, Ill.

New ease, speed and convenience in tumbling small lots of stampings, die castings and similar pieces are afforded by variable speed small lot deburring barrels announced by this firm. Manufacturers of a complete line of deburring, burnishing and drying barrels.

In addition to efficient production tumbling of small pieces, this variable speed unit is ideal for test runs to determine correct rotating speed, the



kind and size of media or abrasive, the best load size and other factors essential to efficient finishing.

The unit can be mounted on a bench or small stand. The barrel is rotated by an enclosed variable speed drive which permits easy adjustment to any rotating speed between 13 and 39 RPM.

Two sliding trays, the top one of which is perforated, afford quick, convenient separation of the work from the media.

Belke Small-Lot Deburring Barrels are available in two sizes. The total capacity of Model 2 is 0.4 cubic feet and Model 3 is 2.0 cubic feet. Complete information furnished promptly on request to the manufacturer.

"Pint-Sized" Filter Pump Units

Sethco, Dept. MF, 105-07 150th St.,
Jamaica 4, N. Y.

Sethco announces a new line of pint-sized filter pump units, in various



models, priced to attract the very small tank operator. These units incorporate all the advantages of simple and economical operation characterizing the Sethco line.

These new models are recommended for either continuous or periodic filtration of all plating solutions. Less than two minutes are required to set them up, and filter tube replacements are long lasting and inexpensive, it is claimed.

The model pictured is Model LSU-5. It is equipped with a type 316 stainless steel pump and a Lucite filter. This model comes complete with a motor, pump and filter mounted on an indestructible, laminated, plastic panel. The 110 volt motor operates on either AC or DC and the entire unit weighs only twenty pounds, making for easy portability. The progress of the filtration can be viewed through the clear Lucite.

The filter tube is made of specially processed cotton yarn, wound around a stainless steel core. This tube is claimed to remove coarse and finely divided impurities, as well as colloidal solids, from the solution being filtered. These filter tubes may be used to filter such highly acid solutions as the acid copper sulphate and the acid copper fluoborate, as well as such highly alkaline solutions as the thin stannate bath and the high speed copper cyanide.

One of the distinct advantages claimed for this unit is that small quantities of solutions as well as expensive solutions may be filtered without any loss. The filter itself holds approximately one pint of fluid.

Sethco's Filter Model LSU-5 is rated at 50 gallons per hour. Filtration rates of greater or lesser flows may be obtained merely by adjusting the pinch valve in the line. For example, by fully opening the valve, an initial rate of flow of 200 gallons per hour may be obtained, while nearly closing the valve will bring the flow down to 1 or 2 gallons per hour.

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RESISTS
CORROSION!

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lower in cost!

Saran lined steel pipe is available in maximum lengths of 10 feet and in sizes from 1 to 4 inches inclusive.

Also available are saran lined plug valves, flanges, reducing flanges, flanged fittings, gaskets and fittings with union ends.

Write us today for further information concerning saran lined steel pipe and how it may solve your problem.

Manufactured by The Dow Chemical Company, distributed nationally by Saran Lined Pipe Company.

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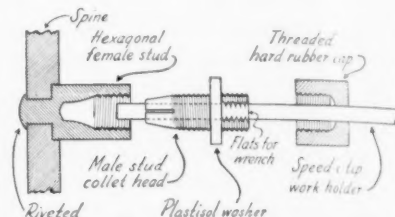
Offices in: New York • Boston • Philadelphia • Pittsburgh • Chicago • Tulsa • Indianapolis • Houston • San Francisco • Los Angeles • Portland • Cleveland • Denver • Seattle • Toronto



Replaceable Plating Rack Tips and Work Holders

Adams Engineering Co., Dept. MF,
34 Crafts St., Newtonville 60, Mass.

This firm announces a complete line of replaceable and interchangeable plating rack tips and work holders. By



using these interchangeable tips, a new rack may be made up in a matter of minutes to take care of special jobs. Only the wire tip need be replaced, which effects considerable savings by eliminating the need for a large stock of plating racks. By using the Adams "Speed-i-tip" plating rack, many combinations are made possible with a small stock of splines. The racks are completely coated with a long-lasting insulating coating, only the wire tips being exposed. A quarter turn of the special collet incorporated in the Adams Speed-i-tip rack enables the wires to be withdrawn and replaced in a matter of minutes. The wires can be made up for any job, and require no special skill to replace or change. A hard rubber cap and plastisol washer protects all the machined parts. Further information is available on these unique racks by writing to the above address.

All-Stainless Sealed Unit Filter

Ferm Industries, Inc., Dept. MF, 95
Wooster St., New York 12, N. Y.

This unit was designed to eliminate the dirty work entailed with most filters; that is the changing of pads, tubes or papers and the cleaning of bags used in a few units. This unit is



claimed to clean itself by reverse action.

The unit, all stainless steel, is welded with stainless welding rod, making it usable for nearly all liquids. There is nothing to assemble or to take apart, merely charge before filtering, then clean.

The A-100 series filter is made for electroplating plants, plating laboratories, precious metal solutions of Gold, Rhodium, etc., alkaline and acid solutions, where fine degree of filtration is required.

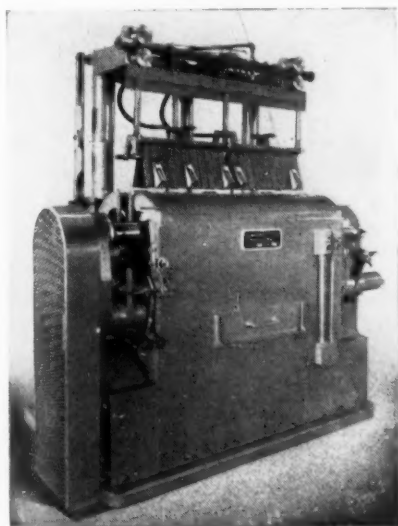
The following features are claimed:

- 1.—The lowest priced filter of its type ever built.
- 2.—Exceptionally fine degree of filtration.
- 3.—No loss of expensive solutions, drainage complete.
- 4.—A portable unit 18" long—12" wide—12" high—weighs 20 lbs.
- 5.—Will filter most solutions.
- 6.—Designed and constructed for years of service.

Contour and Flat Polishing and Glazing Machine

Central Machine Works, Dept. MF,
72 Commercial Street, Worcester,
Mass.

The above manufacturers have just



announced a new Model 5—18" Stroke Hydraulic and Semi-Automatic Glazing and Polishing machine for contour and flat work, such as silverware; jewelry; hand tools; decorative hardware; flat irons; blanking stock; litho plate and hub caps, with considerable saving over present methods now in use. Also made in Model MM with 36" Stroke.



THERE'S no need for paying the cost of excessive rejects when the trouble lies in poor cleaning of the steel surface before you begin your plating operation.

DOUBLE ELECTROCLEANING WITH MAGNUS CLEANERS IS THE ANSWER

First, you clean cathodically for 1 to 2 minutes in Magnus 94XX solution. This special alkaline cleaner for steel (and brass or copper) parts is provided with greatly improved wetting action by the use of a synthetic surface-active ingredient of Magnus' own manufacture. 94XX has the added advantage of giving ample current carrying capacity to provide the densities you want for effective cathodic cleaning. (If you want longer lasting solutions, preclean the parts before electrocleaning in Magnusol.)

Next, clean the work anodically for 1 to 3 minutes in Magnus 61XX. This strongly alkaline cleaner is also provided with the same superior wetting action as 94XX.

When the work is rinsed after anodic cleaning, the usual dilute acid dip is used, the work is again rinsed and is then ready to be plated. It is clean—chemically clean—and should go through any plating operation, automatic or manual, with complete elimination of any rejects caused by ineffective cleaning.

There are special Magnus materials for electrocleaning of die castings and other soft metals, as well as combinations of steel and soft metals. Let us know what you plate and we'll recommend a dependable procedure.

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Here's the New, Proved

faster
TROUBLE-FREE WAY
to produce
MIRROR-LIKE FINISHES
ON NICKEL

Now, your finishing room can finish nickel to a mirror-like gloss or prepare nickel for chrome plating faster, easier—with *Speedie Bright Gloss (Lime)*.

- No. 86-D is an excellent material for cutting and is fairly greasy so that it readily sticks to the wheel.

- No. 1631 is particularly recommended for work that is to be chrome plated after buffing since it is 100% saponifiable

and prevents discoloration of the work.

- No. 1931 is a recently developed product which is ideal for heavy work such as bumpers. A good cutter "for tough jobs".

Learn more about the many other *Speedie* "laboratory-quality", job-proved products . . . Tripoli, Stainless Steel, Satin Finish, Emery Cake, Grease Stick, etc. Write Dept. M.F. for your FREE catalog today.

Polishing Room Supplies and Accessories



THE BUCKEYE PRODUCTS CO.

7033 Vine Street Cincinnati 16, Ohio

Cable address: Buckprod

Chemical-Resisting General Maintenance Paint

United Chromium, Inc., Dept. MF, 51 East 42nd Street, New York 17, N. Y.

A new general maintenance paint with chemical resistance that is said to be far greater than that of ordinary general maintenance paints has recently been placed on the market by the Organic Coatings Division of United Chromium, Incorporated. The new paint, which is known as Ucilon 1701, is based on chlorinated rubber.

The chemical resistance of Ucilon 1701 has been designed to be of service where ordinary oils or oleoresinous paints have not proven satisfactory. Ucilon 1701 is claimed to be of real

advantage in contact with acid and alkali fumes, moisture, vapors, grease and oils, and is usable as a coating for floors, walls, ceilings, exteriors of storage tanks, structural steel and exteriors of certain process equipment and machinery in industrial atmospheres.

Ucilon 1701 is applicable to metals, wood, brick and concrete. It can be applied over old paint or other surfaces without priming and without sandblasting or other expensive surface treatments, it is claimed. Loose rust and scale, however, should be removed. One or two coats is all that is required. Coverage is between 350 and 500 square feet per gallon, depending on the smoothness and porosity of the surface.

Plastic Stop-Off for Plating

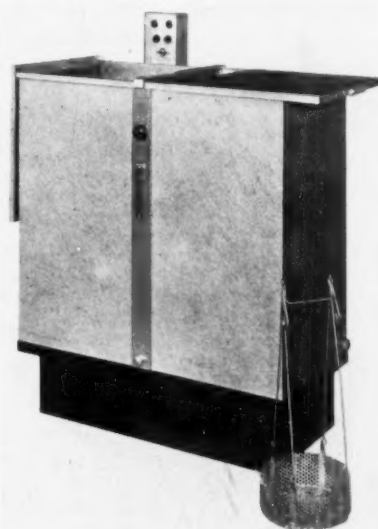
Western Coating Co., Dept. MF, 85 W. Union St., Pasadena 1, Calif.

Recently announced by this firm is a new plastic stop-off material for use in selective plating. The material can be applied by dipping, ladling, or brushing, hardens ready for use in a few minutes, and can be easily stripped off again after plating and the reclaimed material used over again. A temperature of 350°F. is required to melt the plastic, using a thermostatically controlled glue pot or similar device. Parts require only degreasing before application of the stop-off material. It is claimed to be suitable for use in plating chrome, copper, cadmium, nickel, and others. Further details on Maskcoat No. 2 are available by writing direct to the above address.

Stainless Steel Twin-Tank Degreasers

Circo Products Co., Dept. MF, 12117 Berea Rd., Cleveland 11, O.

The new Chief twin-tank degreasing machine is an electrically heated, thermostat-controlled machine, providing a stainless steel hot vapor tank for automatic vapor degreasing, measuring 18" x 18" x 32½", and a galvan-



ized steel dip tank of same dimensions for flushing, dipping and soaking parts to be cleaned.

The hot vapor tank takes five gallons of solvent which is vaporized by heat applied externally through 220 volt electric heating elements. A thermostat near the top of the vapor tank controls the vapor height, preventing loss of vapors into the atmosphere. Another thermostat, located on the

underside of the tank, automatically shuts off the heat when the mixture is too contaminated with grease and oil for further use. An indicator light shows operating conditions at all times.

The adjacent dipping and flushing tank takes approximately twenty gallons of solvent, in which parts may be dipped, soaked or flushed with cold solvent, either before or after hot vapor degreasing, or where vapor degreasing is not required.

This type degreaser is also available in the Clipper model which has approximately twice the cleaning capacity rate per hour, and takes parts almost twice as large as can be cleaned in the Chief degreaser.

Filter Mask Dust Protection

The Goggle Parts Co., Dept. MF, 1468 West Ninth St., Cleveland 13, O.

This firm has announced a new product—Flex-a-Foam filter masks for



protection against non-toxic nuisance dusts. The mask is claimed to be a considerable advancement in industrial dust protection because it is so light, comfortable and smartly-styled that workers welcome and wear it, even in cases where they have previously refused to wear conventional dust protection devices.

The Flex-a-Foam filter mask weighs only one ounce, and is extremely simple in construction, consisting of only four interlocking parts. The filter is a honeycomb construction of whipped foam latex ventilated by hundreds of tiny inter-connecting cells that allow the passage of air but keep out non-toxic nuisance dusts as small as 1/25000 of an inch, it is claimed. Inner and outer frames are of polythene plastic, so flexible they adjust themselves to the contours of any face,

THE Balanced Solvent



BLACOSOLV

STABILIZED *NOT* ALKALIZED

ONE solvent, ONE price for all jobs

The new Blacosolv is the most stable solvent we've ever offered for metal degreasing. Aluminum, steel, copper and precious metals may be safely and scientifically degreased with the same solvent.

Blacosolv contains a mixture of entirely new and different stabilizers. They are not alkaline materials which neutralize acid *after* breakdown. They are new stabilizers that *prevent* solvent breakdown and possible acid formation. Contains no alkaline materials that can be mistaken for stability . . . no masking agents are added.

USE BLACOSOLV
IN *ALL*
SOLVENT-VAPOR
DEGREASERS



BLACOSOLV
DEGREASERS AND SOLVENT

G. S. BLAKESLEE & CO.

G. S. BLAKESLEE CO., CHICAGO 50, ILLINOIS
NEW YORK, N. Y. TORONTO, ONT

NIAGARA
METAL PARTS WASHERS

yet so strong they're indestructible in normal usage, according to the firm. Flex-a-Foam's headbands are molded of natural rubber of a non-toxic, non-irritating quality. All parts can be sterilized by washing in warm, soapy water and immersing in a mild formaldehyde solution.

New Di-Phase Cleaner

Chemclean Products Corp., Dept. MF, 64 Sixth Avenue, New York, N. Y.

This firm announces the development of Chemclean #133, a new "di-phase" cleaner, unique in its action for pre-cleaning all metals without attack. This material is claimed to remove buffing and drawing compounds, oils, greases, etc.; is safe to work with,

simple and very inexpensive to use; it eliminates all hand operations.

To make up the bath, pour 1 volume of Di-Phase #133 on 3 volumes water (the No. 133 floats on top) and the tank is ready to work. Objects can be in either phase, #133 or water. The parts are allowed to remain 2 to 5 minutes in the solution, removed, and without rinsing, put through either a mild alkali soak cleaner or directly into an electro-cleaner.

The di-phase cleaner can be used in conjunction with a vapor degreaser advantageously, but in many cases users are said to have eliminated vapor degreasing entirely. Experience has also shown that work put through #133 without further processing will resist rust for some time.

Eversharp has the "write" answer... 

in dust control systems . . . it's KIRK & BLUM!

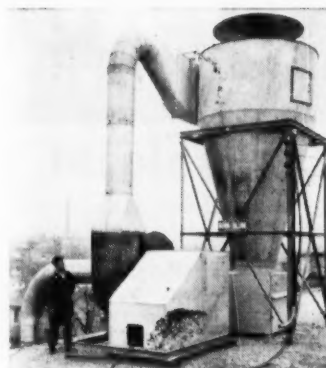


In the above photo, operators are buffing fountain pens already filled with ink. Note redesigned hoods which keep room clean and free from dust.

Known as a manufacturer of precision writing instruments Eversharp finds "clean air, the invisible tool," essential to efficient manufacturing operations. On moving one of its plants to Middletown, Ohio, this concern called in KIRK & BLUM to modernize and enlarge the dust control system.

Among other changes, hoods on the buffing machines shown here were redesigned. Former bottom connections were used as traps and new connections were added at the top of the hoods. Note the compactness of hood arrangement and streamline suction piping in the limited space available.

If you suspect your present dust control system is outdated and overloaded, Kirk & Blum Engineers will gladly check it for you, making a no-obligation report. Write for free catalog, "Fan Systems for Various Industries." The Kirk & Blum Mfg. Co., 2889 Spring Grove Ave., Cincinnati 25, Ohio.



On the roof of the Eversharp plant, KIRK & BLUM relocated an old collector for greater efficiency and installed this new collector.

FOR CLEAN AIR . . . THE **KIRK AND BLUM** TOOL

KIRK AND BLUM

DUST CONTROL SYSTEMS

Self-Illuminated Industrial Microscope

Clarkstan Corp., Dept. MF, 11927 W. Pico Blvd., Los Angeles 34, Calif.

A new industrial microscope with self-light source and reticle has been announced in the low priced field.

Model No. 232 is designed for all types of general industrial work, for use in the laboratory, shop, or for production. Wherever a high quality, medium power microscope is necessary, this industrial instrument fills the need. It is fine enough for exacting work yet very reasonable in cost, and the built-in illumination and measuring scale (reticle) and high quality optics are



usually found only in the more expensive instruments.

With a magnification of either 20X or 40X, this microscope has excellent resolving power and light efficiency, it is claimed. No external illumination is needed, as the microscope has its own built-in light source. Standard cell and prefocused lights, available in the open market, provide ample concentrated light over the entire field. For quantitative measurement and analysis of all types, a reticle has been incorporated for direct measurements with divisions of .004" and .002" for respective powers.

The eye point is over 1" above the eye piece. This enables the operator to work when wearing glasses, thus providing corrected vision for all examination. Focusing by means of the friction sliding tube is easy and positive.

Finish is in black, polished chrome, and deep maroon baked enamel. The instrument is portable, and has its own wooden dovetail-jointed carrying case—with battery, light and extension.

New Finish for Stainless Steel

Atlantic Brass Works, Inc., Dept. MF, 2600 W. Addison St., Chicago 18, Ill.

The Atlantic Polishing Mill, specializing in polishing stainless steel sheets, plates, tubes and bars, is now furnishing a new finish. Stainless fabricators using this new finish, known as #4D, found the following advantages over #4: (1) less cost, (2) ease in matching, where blending is necessary due to welding or soldering joints, (3) sales appeal—claimed to be as good as #4.

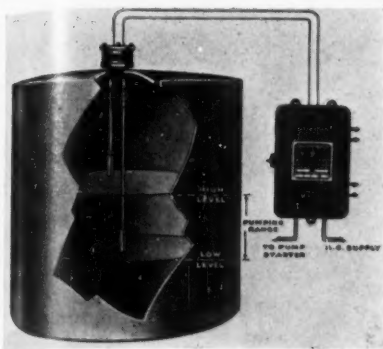
Atlantic Polishing Mill has been furnishing #4 finish at a cost less than Mill #4, and now offers even greater savings with the #4D finish, plus the advantage of permitting purchase of requirements from one or more sources and have a uniform #4 or #4D finish in stock.

Samples of #4 and #4D finish will be furnished on request.

Liquid Level Control

Photoswitch, Inc., Dept. MF, 77 Broadway, Cambridge 42, Mass.

This firm announces Level Control Series 10, which makes available a completely maintenance-free level control to the chemical processing fields. With this unique design, contact with



the liquid is made only through stainless steel probe rods. No floats or other moving parts are required in the tank. The control consists of an electrical relay operating from a probe circuit through a transformer and a rectifier—no vacuum tubes are used. Accuracy is independent of temperature and pressure.

Series 10 Level Control is recommended for all electrically conductive liquids. It is not affected by the saturated vapor above the liquid in a closed tank, permitting positive control of acid in batch processing. It will discriminate between a liquid and its foam.

As indicated in the above sketch, the two probe rods which are wired to the control project into the tank to the levels corresponding to the low point where pumping is to start and the high point at which pumping stops. When the level of the liquid in the tank falls below the lower probe, the level control closes the electrical circuit controlling the pump or valve. When the liquid rises to the level of the upper probe, the fluid acts as a conductor of the minute current at low voltage required for operation of the relay and the central circuit opens.

The equipment is flexible to serve as a pump-up or pump-down control, a high or low level safeguard, and to provide for the sequencing of two or more pumps.

Check Solvent Safety Before Winter Comes

As the end of summer approaches, ventilating arrangements and other safeguards intended to protect workers in solvent-using departments should be re-examined.

During the summer months, it may be that natural ventilation from windows and doors has taken care of some of the load of removing solvent vapors.

How to have a better-looking plant and **SAVE** on maintenance

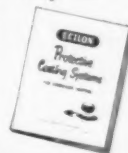


UCILON Protective Coating Systems stop corrosives
—give life-saving protection to metal, concrete, wood!

Of course you can have an attractive plating department and cut costs too. For when you apply Ucilon Coating Systems, you get a job that stands up despite the strong corrosives and excessive moisture.

One well-known company, for instance, had its entire plating department protected with Ucilon coatings—including tanks, walls, concrete floor, ducts. These coatings have resisted attack for better than *two years*—and they're good for much more!

Ucilon Coating Systems resist continuous contact with acids, alkalies, water, cleaners, as well as fumes and splashing from plating baths. Spray or brush them on wherever corrosion is costing you money. Ucilon coatings are helping hundreds of concerns to maintain equipment in tip-top condition while reducing frequency and expense of painting. To learn how they do it, send today for this 32-page booklet on corrosion control with Ucilon Coating Systems.



UCILON* Protective Coatings



products of UNITED CHROMIUM, INCORPORATED

51 East 42nd Street, N. Y. 17, N. Y.

*Trade-Mark Reg. U. S. Pat. Off.

Detroit 7, Mich. • Waterbury 90, Conn. • Dayton 2, Ohio • Chicago 4, Ill. • Los Angeles 13, Calif.

With the drop in temperature, this source of ventilation will be cut off and other means of vapor removal, such as mechanical ventilation, will increase in importance. It is therefore desirable to check ventilating systems before the winter season to make certain that they are adequate, functioning properly and in good repair.

During warm weather, occasional jobs with solvents may be done outdoors. When such work is moved indoors, respirators are often depended upon to prevent vapor inhalation. Respirators, too, should be checked to make certain that they are in good condition and ready for use. Where canister-type respirators are provided, it is important to check the service rec-

ord of the canisters to assure that their contents have not outlived their usefulness.

Winter months may bring an increase in dermatitis, because of the increase in dry, chapped skin. A good lubricating cream, provided near the washstand, will be helpful in preventing skin difficulties from solvents.

Rust Preventative

Temperature Equip. Corp., Dept. MF, 4505 Euclid Ave., Cleveland 3, O.

EHW formula, a rust preventative for protection of metals in the home and industry, is now available for household and commercial use.

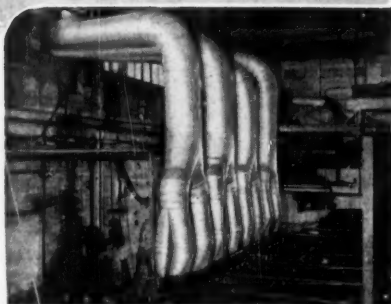
Ohio FUME AND DUST REMOVAL SYSTEMS

TANGIBLE DOLLAR SAVERS

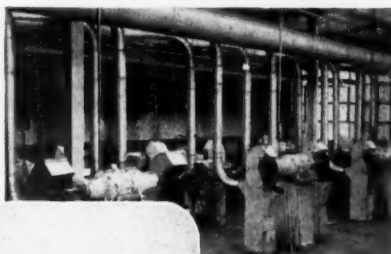
● Records on hundreds of Ohio Blow Pipe jobs prove without question that production output materially increased and employee absence and complaints radically decreased after the installation of an Ohio System for ventilation of fumes from plating and rinse tanks and dust collection from grinding, polishing and buffing.

Ohio Systems are not standard fit-all systems. They are designed and engineered to meet your individual requirements. Ohio engineers, thoroughly experienced in their field, make a careful, exacting survey of your plant and an analysis of conditions and then plan the system that will meet most efficiently your special needs and conditions.

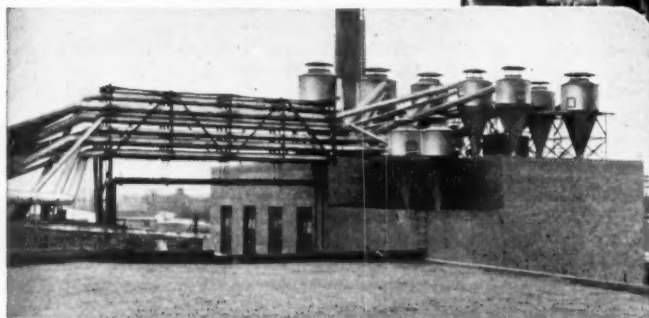
Call, write or phone today and let Ohio engineers make a survey and give you, without obligation, an estimate.



Fumes Removal Installation in Plating Room



Dust Collecting System for Buffing Machines



Cyclone Type Dust Collectors

Ohio BLOW PIPE CO.
ENGINEERS AND MANUFACTURERS
1725 DOAN AVENUE • CLEVELAND 12, OHIO



The formula, developed by *E. H. White-lock*, prominent Cleveland metal finishing consultant, provides a protective coating for all metals and plated surfaces against rust, corrosion, pitting and tarnish, it is claimed.

EHW provides a tough, transparent and colorless coating that is claimed to withstand weather, heat, cold, grease, grit, etc. It can be removed with standard acetates. One application on automobile chrome provides protection up to a year, and most indoor applications last indefinitely, it is claimed.

Unlike other preparations made for its purpose, EHW formula is not a plastic. It can be applied by brushing, spraying or dipping. It dries in two minutes, can be handled in five min-

utes, and in 4 to 8 hours it reaches final hardness.

Business Items

E. G. Schroeder New Sales Manager of Electric Products Company

Mr. G. J. Berry, Vice President and Sales Manager of *The Electric Products Company, Cleveland, Ohio*, takes pleasure in announcing the appointment of *Mr. E. G. Schroeder* to the position of Field Sales Manager. In his new position Mr. Schroeder will supervise all district sales activities.

Mr. Schroeder brings to his new position a broad experience in electri-



E. G. Schroeder

cal sales and engineering gained by a year with the New York State Electric and Gas Corp., and over seven years with the General Electric Co. He joined *The Electric Products Co.* in October, 1945 to head-up their Detroit District Office.

Verzier Joins Roberts Rouge

The Roberts Rouge Company, Stratford, Conn., is pleased to announce the addition of *Mr. Verne Verzier* to their staff.

Mr. Verzier is recognized as one of the outstanding authorities on Glue Chemistry and Abrasives. A graduate of RPI, he is a Licensed Professional Engineer, a member of the Electrochemical Society, American Chemical Society and the American Electroplaters Society, and for some years has been one of the outstanding men in the compound industry.

He was formerly associated for 11 years with the *Lea Mfg. Co.* as Chief Chemist, and recently severed his connection with the *Lupomatic Tumbling Barrel Co.*, where he did extensive development work with tumbling techniques and abrasives.

Optimus Equipment Co. Appoints Morris President

Optimus Equipment Co., Matawan, New Jersey, manufacturers of vapor degreasers, metal parts washers, pickling and drying equipment, has announced the appointment of *Melville Morris* as President. Mr. Morris has been Executive Vice President of the company, which is a subsidiary of *Hanson-Van Winkle-Munning Co.*, also



Melville Morris

of Matawan. The appointment follows in line with plans for enlarged operations contemplated at this time.

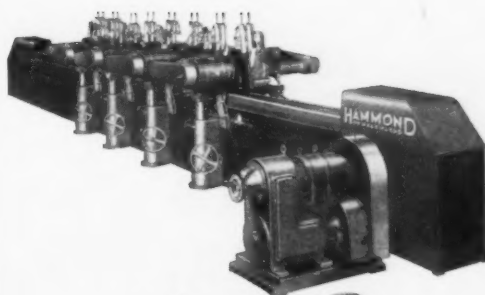
Clayton P. Yoder Named Sales Manager for Kold-Hold Division

Clayton P. (Bill) Yoder has been appointed sales manager of the Platecoil Division of the Kold-Hold Mfg. Co., according to an announcement by J. R. Tranter, President. Mr. Yoder's immediate activities will include establishing sales representatives in the leading industrial areas of the country. He will have charge of training personnel and general promotion of the products of the Platecoil division.

Yoder is a widely known and highly respected authority on industrial electric heating. His diversified background in this field includes operation of his own sales agency in Buffalo, where he sold electric heating equip-



C. P. Yoder



FASTER FINISHING

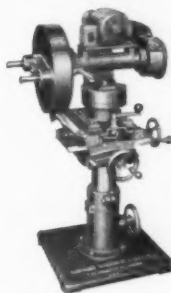
WITH

Hammond

STRAIT-LINE
AUTOMATICS

ROTARY AUTOMATICS

JUNIOR
AUTOMATICS



There are ten new Junior Automatics in the Hammond Line, to be used with polishing or buffing wheels or with abrasive belts. Model E2PF shown.

Users of Hammond Automatics report 2000 pieces or more per hour, more uniform, better finishing, less operator fatigue and specially, lower costs.

Send one finished and several rough samples for complete engineering and production report at no cost or obligation.

Let us show you what a Hammond Automatic can do on your own work to speed-up production and reduce your finishing costs.

**"HAMMOND OF KALAMAZOO
Good Machinery Since '82"**



Hammond Machinery Builders

1601 DOUGLAS AVENUE ★ KALAMAZOO, MICHIGAN, U. S. A.

ment, utility line materials and related items. He was associated with the General Electric Co. for many years, the last ten as head of the Standardizing Laboratory at Erie, Pa. In 1926, he joined the Erie County Electric Co. as a Power Sales Engineer and later was promoted to Sales Manager. From 1931 until he started his own business, he was connected with the Buffalo Niagara and Eastern Power Corp. He was Industrial Heating Engineer, then Manager of the Power and Heating Bureau and later was Manager of the Commercial and Industrial Bureau.

An associate of the American Institute of Electrical Engineers since 1918, Mr. Yoder was one of the organizers and first chairman of the Erie Section.

Minnesota Mining to Have Two New Branch Offices and Warehouses

The Minnesota Mining & Manufacturing Co. occupied two new combination branch office and warehouse units in Ridgefield, N. J., and Grand Rapids, Mich.

The Grand Rapids building contains about 10,000 square feet of floor space and the Ridgefield branch 53,500 square feet. Both will be leased by 3M from the builder-owners. Each is served by a rail siding and "complete truck loading facilities," the announcement said.

Both new branches will replace present locations, but the firm's announce-

**How to get
Finer Finishes
at Lower Costs**

with **GLOBE** Direct Motor Drive **TILTING TUMBLING BARRELS**



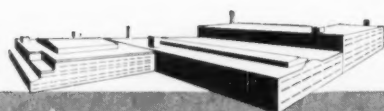
**Available in
Kiln-Dried Maple
or Steel Shells**

Process thousands of pieces at one time—faster, better and at lower cost—with Globe Precision Tumbling Barrels, dependable for 47 years. Globe's exclusive six-way work shifting motion cuts tumbling time and increases action. Speeds as low as 30 revolutions per minute assure finer finishes of non-ferrous metal parts. Motor is compactly mounted above the gear segment for space economy.

Free Experimental Service

Hupp's Experimental Engineering Laboratory can show you how to cut finishing costs. Just send samples of the parts to be processed along with a finished part. Write today! There's no charge or obligation.

**Hupp Manufactures a
Complete Line of Tumbling Barrels
and De-Burring Machines.**



HUPP CORPORATION

GLOBE STAMPING DIVISION

1250 WEST 76th STREET • CLEVELAND 2, OHIO
SERVING INDUSTRY SINCE 1902

ment emphasized that "there will be no interruption of our service" during the moves, and added that customers should "receive better, faster service because of improved facilities."

Ridgefield will serve the entire New York area, eliminating the present branch at 155 Avenue of the Americas, New York City.

Superior Plating and Polishing Co. Assumes New Name and Ownership

John F. McCann and VeDell E. Guernsey announce that they have assumed ownership of the Superior Plating and Polishing Works, 77 Hickory Street, Johnstown, Pa. The business will be continued as the *Johnstown*

Plating Company. Complete facilities are available for plating industrial and decorative chrome, nickel, zinc, silver, cadmium and copper. Mr. McCann and Mr. Guernsey were formerly associated with the Electro-Chemical Dept. of the Western Electric Co., Baltimore, Md., as electro-chemical development engineers. In addition to electroplating, both men have had considerable experience in the electropolishing and electroforming fields.

Mr. McCann, a native of Patton, Pa., was graduated in Chemistry from St. Francis College, Loretto, Pa. He pursued further study in metallurgy at Penn. State College and studied Chemical Engineering at The Johns Hopkins Univ. in Baltimore, Md. He is a member of the American Chemical



John F. McCann

Society and holds membership in the American Electroplaters' Society.

Mr. Guernsey, coming from Perinton, Mich., graduated from Alma College, Alma, Mich., with a B.S. Degree in Chemistry. His earlier experience prior to developmental electrochemistry was in job plating shops in the Lansing, Mich., area. During World War II, he served 4½ years as



V. E. Guernsey

a naval officer in the Pacific. He holds membership in the American Electroplaters' Society.

Younger New Sales Manager For Atlas

George L. Wirtz, President of the *Atlas Mineral Products Company*, Mertztown, Pa., announced today that A. Myles Younger has been elected Vice President in Charge of Sales. Mr. Younger joined the firm as a Chemical Engineer in 1939 and in the



A. Myles Younger

interim has held positions as Midwest Sales Manager, Plant Manager of the California Plant, General Manager of the Texas Division, and General Sales Manager.

Detrex Advances E. W. Allison

E. W. Allison has been elected Secretary-Treasurer of Detrex Corp., De-



E. W. Allison

troit 32, Mich., manufacturers of industrial and dry-cleaning equipment and chemicals, according to an announcement by A. O. Thalacker, Vice-President and General Manager.

Mr. Allison, who has been with the company since 1941, has progressively advanced through the Legal Department, and the positions of assistant secretary and secretary of the company. In addition to taking charge of the financial operations of the company, including the accounting and credit departments, he retains his duties as sec-

Problem

Solution

Result

To cut overhead with buffs that stand up longer at high speeds.



More economy with "Cutmaster" buffs. Cloth cut on bias —cannot fray out.

WILLIAMSVILLE BUFF DIVISION

The Bullard Clark Company
DANIELSON, CONNECTICUT

retary with supervision over the legal and personnel departments.

Prior to joining Detrex, Mr. Allison graduated from the University of Michigan Law School, from which he holds A.B. and J.D. degrees, and spent six years with a Detroit law firm. He is past president of the Michigan Club of Detroit and a member of the Detroit Boat Club and the Recess Club.

G. E. Powers, whom he succeeds, has retired after 25 years with the company. To Mr. Powers goes credit for the sound financial condition of the company which has grown to a business that is international in scope, having patents in 17 foreign countries. Mr. Powers will act as consultant on financial matters and will remain on the Board of Directors.

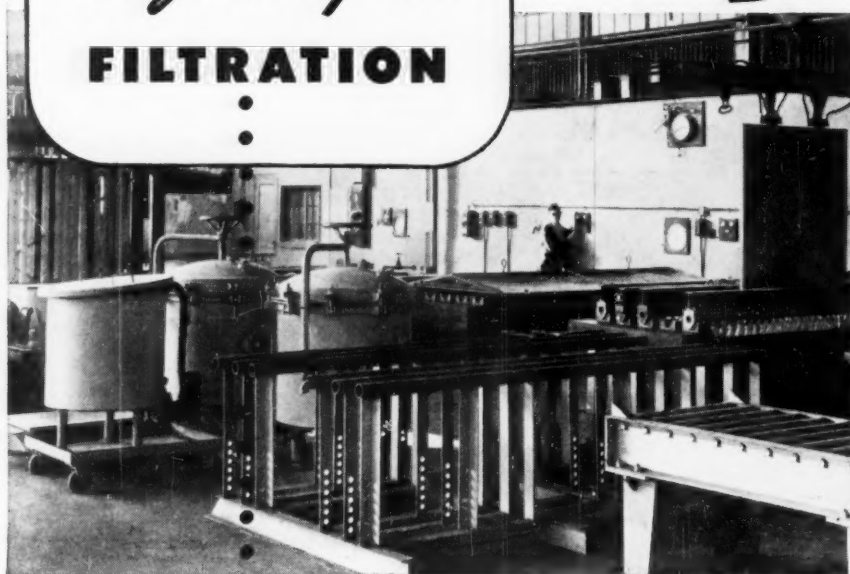
Tin Research Institute to Provide Technical Information and Service on Tin

This corporation has been organized to provide free technical service to users of tin in the United States. Technical experts are available for consultation and practical assistance either at the Institute or at Consumers' plants.

Mr. R. J. Nekervis has been appointed Supervisor of Metallurgical Development, and Mr. R. M. MacIntosh has been appointed Supervisor of Chemical Development. Both appointees have been with Battelle Memorial Institute for the last eight years where they have been handling problems connected with tin. All service and technical information is given free of charge

SPARKLER *horizontal plate* FILTRATION

Plating solutions are circulated through this battery of Sparkler Filters in the Lukens Company plating plant at the rate of 5000 gallons per hour.



..... means cleaner surfaces
for cladding steel

Lukens Steel Company, pioneer manufacturer of clad steels, has found that Sparkler Horizontal Plate Filtration is important in the production of Inconel-Clad and Stainless Clad Steel.

Here's the way it works:

Oxide film, which forms easily on the bonding surfaces of all steels, acts to prevent a strong, intimate bond between these cladding metals and backing plates. Lukens, to overcome this, applies a nickel plate finish to these bonding surfaces. In the new, modern Lukens plating plant, Sparkler filters serve as assurance that this nickel plate will be perfectly clean and free from foreign matter, thus providing the best possible surface for an inseparable bond.

The horizontal plate principle used by Sparkler makes possible the formation of firm, stable filter cakes that will not slip or crack under intermittent or continuous flow. Flow through the filter is always *with* gravity, and filter aid is floated into position, forming a strong cake of even thickness that effectively removes all solids and precipitates from plating solutions. Filters are pressure-tight and leakproof, and are available in rubber-lined construction, stainless steel, or iron. Capacities from 60 to 10,000 G.P.H.

Our Engineering Service is available for your specific problems.

SPARKLER MANUFACTURING COMPANY
Mundelein, Illinois

and inquiries are invited. The address is 492 W. Sixth Ave., Columbus 1, Ohio.

Minnesota Mining Makes Executive Appointments

Five promotions in top-level management of the *Minnesota Mining & Manufacturing Co.*, St. Paul, Minn., have been announced recently.

William L. McKnight, president of the firm since 1929, has been elected to the newly created post of chairman

of the board. His successor to the presidency is *Richard P. Carlton*, former executive vice president in charge of research, engineering and manufacturing.

Archibald G. Bush, former executive vice president and director of marketing and distribution, becomes chairman of the executive committee.

Two new executive vice presidents have also been named. They are *George H. Halpin* and *Herbert P. Buetow*. Halpin, former vice president for sales, will continue to direct sales

activities. Buetow, 3M's treasurer since 1939, becomes executive vice president in charge of finance.

Lloyd A. Hatch, vice president formerly in charge of the firm's roofing granule division, has been assigned the job of coordinating research and new product development.

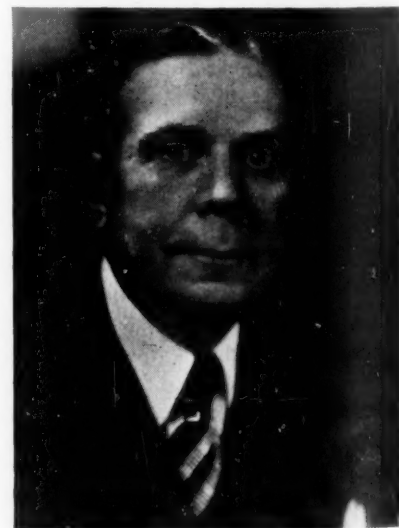


William L. McKnight

Hatch, who joined the company in 1923 as a chemist, was elected a vice president in 1946. He has been active in the development and management of the roofing granule division from its beginning about 16 years ago.

Clarence B. Sampair, V.P. Production, has been an employee of 3M since 1927. He was named production manager in 1940 and elected vice president in 1946. His new responsibilities will include labor relations.

In addition to directing engineering and related operations, Vice Pres. *C. P. Pesek* will now be in charge of



Richard P. Carlton

all company property. He has been with the company for six years, and has been a vice president since 1947.

Charleson New Finishing Supt. at Yale & Towne as Manning Retires

The retirement of *James F. Manning* and the appointment of *John E. Charleson* to succeed him as superin-



J. E. Charleson

tendent of the finishing department of the Stamford Division of *The Yale & Towne Manufacturing Co.* were announced recently by Works Manager *Harold E. Nagle*

James F. Manning retires with a total of 47 years employment at Yale & Towne. He served in the rates and methods departments before he was transferred to the finishing department, where millions of locks are annually given their final surface treatment. He was promoted to general foreman in 1928, and to department



J. F. Manning

superintendent in 1936. Mr. Manning has also been a leader in Stamford's civic affairs. He was chairman of the Board of Public Safety for two years, and served as a member of the Board of Finance of the Town of Stamford for several years.

Mr. Charleson has been continuously associated with Yale & Towne for the past 26 years. He started with Yale & Towne in 1923 in the chemical laboratory, and in 1945 he became chief engineer of plating and finishing.

Mr. Charleson is widely known in the metal industry, and is a past president of the Bridgeport Chapter of the American Electroplaters Society.

Commercial Filters Opens Chicago Sales Office

Commercial Filters Corp., of Boston,

Mass., manufacturers of FULFLO Filters and Cartridges for the microscopic filtration of all industrial and commercial fluids, have just opened a Mid-Western Sales Office at 603 *West Washington Blvd., Chicago.* The new office will be in charge of *Mr. Walter H. Magee.*

Ehlert New Detrex Mid-Western Regional Manager

Appointment of *E. H. Ehlert* as region manager of industrial cleaning equipment and chemical sales, for mid-western states has been announced by *L. Camel*, sales manager of the industrial division of *Detrex Corp., Detroit 32, Mich.*

Mr. Ehlert, whose headquarters will be in Chicago, studied mechanical engineering at Case School of Applied

CHROMIC ACID

99.75% PURE



SODIUM BICHROMATE
POTASSIUM BICHROMATE

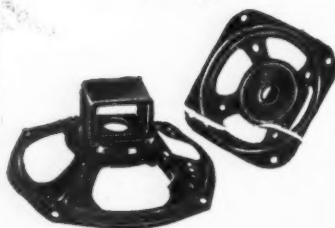
MUTUAL CHEMICAL COMPANY OF AMERICA

270 Madison Avenue, New York 16, N. Y.

REDUCE YOUR METAL FINISHING AND HEAT TREATING COSTS

... WRITE WIRE PHONE ...

Your metal finishing and heat treating costs must decrease if you take advantage of our quality products and highly specialized engineering skill. Write, wire or phone Bridgeport 7-1390 or 7-1194 and one of our engineers will survey your requirements.



BLACK-MAGIC

ONE-BATH METAL FINISH

BLACK-MAGIC, a simple, inexpensive, one-bath black oxidizing process for steel, is way out in front because of highest quality materials, engineering skill, and prompt, efficient service. We have products and processes for coloring steel, iron, brass, copper, zinc and cadmium, metal cleaners, rustproof coatings and dips and metal treating salts.

Quick-Carb carburizing salts, Quick Temper tempering salts and Neutral salts perform fast and efficiently over all required temperature ranges.

MITCHELL-BRADFORD CHEMICAL COMPANY
MODERN METAL FINISHES

• 2446C MAIN ST., STRATFORD, CONN. •

BLACK-MAGIC OXIDE BLACKING SALTS
WITCH-DIP & WITCH-OIL FINAL FINISHES



SILCO Glass-Base PROTECTIVE COATING
HEAT TREATING SALTS, CLEANERS, ETC.

Science and was in business for himself for ten years before he joined the field sales and service staff of Detrex in 1943. Here he obtained wide experience in the solution of industrial processing problems involving both solvent-vaor degreasing and alkali cleaning. In 1948 he was made Manager of the Detroit industrial sales office, in which capacity he correlated sales with engineering work on all large cleaning and processing equipment design and installation.

W. J. Miller, who also joined Detrex early in 1943, has been placed in charge of the field application of Detrex alkali and emulsion cleaning compounds and coating materials for the mid-western states. He has had broad experience in

the sale and servicing of all types of industrial cleaning chemicals and equipment.

Belfield Adding to Selling Staff

The Belfield Valve Division of Minneapolis-Honeywell Regular Co. is adding to its field sales staff in a new and expanded sales and manufacturing program. This program, according to W. H. Steinkamp, field sales manager, will cover the entire country and its efforts will be directed to all types of manufacturing and processing industries, Steinkamp said.

Those assigned to full time on regional valve sales are: Russell A. Schlegel for the eastern region, with headquarters in New York; George

Brown for the central region, with headquarters in Cleveland; Robert Scott in the midwest and northwest regions, with headquarters in Chicago, and William Clements in the Pacific, north coast and mountain regions, with headquarters in Los Angeles. All of these new appointees were formerly members of the field sales staff of the Brown Instruments division of the Honeywell organization.

Wild New Asst. Sales Manager for Prufcoat Laboratories

John G. Wild, specialist for the past twelve years in the field engineering of synthetic resin coatings, has been appointed Assistant Sales Manager of Prufcoat Laboratories, Inc., of Cambridge, Mass., manufacturers of special protective coatings widely used throughout industry wherever chemical corrosion is a problem.

Blast Cleaning Machinery Financed on Low-Cost Plan

A liberal deferred payment plan for the purchase of machinery has been announced by American Wheelabrator & Equipment Corp., 555 S. Byrkit St., Mishawaka, Ind.

The plan enables plants to acquire Wheelabrator airless abrasive blast cleaning, dust collecting and foundry equipment at the lowest possible financing cost and without dissipation of working capital.

A concern taking advantage of the plan pays only 25% down on or before shipment, and the balance in equal monthly installments extending from 6 to 30 months. Interest rates vary in accordance with the length of time over which the unpaid balance is to be financed. The average interest rates range from 2.17% for 12 months to 3.1% interest for 30 months, because only simple interest is charged on the unpaid balance.

News from Detroit

HOWARD PLATING INDUSTRY has recently completed a 4000 square foot addition to their present plant in Royal Oak, Michigan. The new addition was necessary to alleviate a serious stock storage problem. This firm is now engaged in cadmium and zinc plating on a jobbing basis.

HARDING MFG. CO., 18600 Grat-

lot, Detroit, has revamped their copper, nickel and chromium line to handle all types of base metals including aluminum. Increased business made the change necessary. Harding Mfg. claims to be the first job shop in Detroit to plate on aluminum as a part of their regular production.

METALS PLATED, INC., 21740 Wyoming, Oak Park, Michigan, announces the addition of a gold and silver plating service to their production plating plant. The new service will include custom refinishing and repairing of gold, silver and antique articles and is designed to meet the needs of the jewelry trade and the public. *E. L. Beichtol*, president, who has been in plating work for 40 years, originally worked for Wm. Rogers and, in addition, manufactured holloware. A pick-up and delivery service is available for Detroit and its metropolitan area. This shop also plans to initiate a nationwide advertising program in October designed to reach the smaller towns and areas that are not serviced by any plating shops. They plan to refinish automotive parts particularly for garages and persons located in such areas.

Associations and Societies

AMERICAN ELECTROPLATERS' SOCIETY



Philadelphia Branch Annual Educational Session

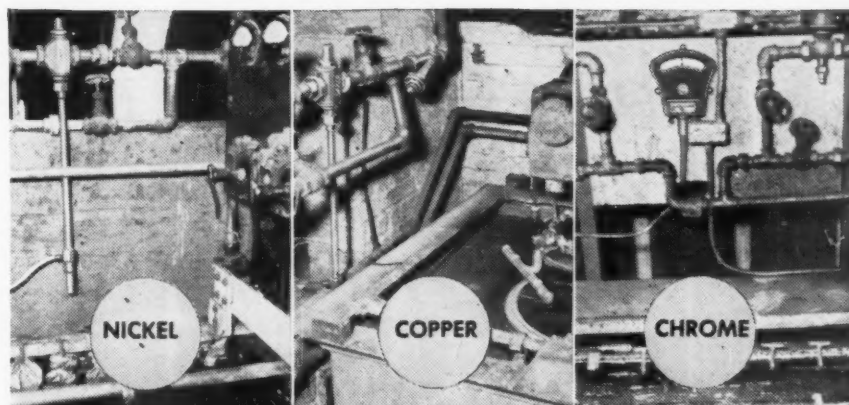
The Philadelphia Branch of the American Electroplaters' Society will hold its Annual Educational Session and Banquet at the Broadwood Hotel, Broad & Wood Sts., Philadelphia, on Saturday, November 19, 1949.

The educational session will start at 1:30 p.m.

Speakers will be:

Dr. William Blum, Chief, Electrodeposition Section, National Bureau of Standards, Washington—"New Directions for Research in Electrodeposition"

Mr. Alfred Douty, Chief Chemist, American Chemical Paint Co., Ambler, Pa.—"Pickling, Inhibitors and Embrittlement"



PRECISION PLATING With 3 Sarco Temperature Controls



Any plating engineer knows exactly what he wants in temperatures for the various jobs going through his plant. Few realize that the very controls he needs are waiting for him and can be installed quickly at comparatively little cost.

Starting with the wash tanks he can get a suitable control in the Sarco 87 Thermoton for the cost of a good steam trap.

For greater refinements in control the Sarco TR-22 illustrated and the Sarco TR-21 control are available. For chrome he can add automatic cooling at little cost.

For most plating jobs he can keep temperatures within a degree or two with the inexpensive Sarco LSI Electric Controls.

187

SARCO

SAVES STEAM

SARCO COMPANY, INC.

Represented in Principal Cities

Empire State Building, New York 1, N. Y.

SARCO CANADA, LTD., TORONTO 1, ONTARIO

Mr. Henry Mahlstedt, Sales Manager, Electrodeposition Division, United Chromium, Inc., New York—"Chromium Plating"

The banquet will be held at 7:00 p.m. followed by entertainment and dancing. Tickets for the banquet are \$5.00 per person; there is no charge for admission to the Educational Session.

Rochester Branch

The first meeting of the 1949-1950 season for the Rochester Branch of the A.E.S. was called to order by the President, *Mr. Joseph Hull*, at the Ukrainian-American Club.

A motion was made by *John Adams* and seconded by *John Lenzi* that all

members be suspended who were two (2) years or more behind in payment of dues as of Sept. 24, 1949. The motion was carried.

The majority of the members present indicated that the third Monday of each month was best for the meeting date. The Ukrainian-American Club was set for the meeting place. It was suggested that the next meeting be held as a dinner meeting starting at 6:30 P.M., and the business meeting to follow.

Librarian *John Duford* asked for suggestions on topics of interest to the group for the coming year. Questionnaires were to be made available for each member to indicate his preference of subjects.

A motion was made and seconded

No ALIBI •

Alibis are not needed for BUNATOL No. 1000 Paste rack insulation. It does a real job and excuses are not necessary. Actual results out in the shop tell the story.

You should get the facts about No. 1000 Paste. It's low in price and easy and simple to use. In labor, time and cost, rack insulation is simplified. The only unusual point is that an oven is required to bake the insulation.

Very long insulation life is another factor. One of the very large shops where they use BUNATOL advises us that frequently racks wear out before the insulation. In every case No. 1000 long out-wears any of the ordinary kind.

No. 1000 Paste is 100% solids plastisol. There is no evaporation loss. The insulation is thick and very tough, and not only withstands all plating solutions but rinses freely and does not drag out.

Regardless of what insulation you are now using investigate BUNATOL. Send us a rack and we will insulate it without charge so you can run an actual shop test. Do this now.

Nelson J. Quinn Company Toledo 7, Ohio

that the treasurer be paid Twenty-five Dollars (\$25.00) annually to cover miscellaneous costs incurred in the performance of his duties. Refreshments were served in the meeting room.

Detroit Branch

The first meeting of the fall season of the Detroit Branch of the American Electroplaters Society was held on Friday, September 9th, at the Hotel Statler. The attendance was good with approximately 150 members attending.

New members were elected to the branch. *Ed Hahn*, membership chairman, has promised to bring a hundred new members to the Society this year. Inasmuch as 69 new members were gained last year, he expects this task to be plenty hard.

Bert Lewis, Northwest Chemical Co., has been appointed chairman of the nominating committee for the annual branch election.

A moment of silent prayer was held for the three members of the branch who died this past summer.

A movie was shown as part of the educational program. This was followed by the speaker of the evening, *W. A. Corse*, of the Carborundum Company who spoke on "Surface Preparation Before Plating." The talk covered three comparatively new methods of polishing; Mechanical flat polish with abrasive belts prior to forming; Manual polishing by belt back-stand method after forming; Manual or mechanical polishing by brush-backed sander head. The last method aroused considerable interest inasmuch

as it is new to metal finishing, but not to wood finishing where it has been in use for some years.

Liquid refreshments were served after the meeting was adjourned.

Detroit Branch—Annual Educational Meeting

The Annual Educational Session of the Detroit Branch will be held beginning at 2:00 P.M. at the Statler, on Saturday, December 3, 1949. Featured speakers will be *W. M. Phillips* and *Frank Clifton* of General Motors Research. Their subject will be "Instruments—Their Use and Importance in Electroplating Operations." Mr. Phillips and Mr. Clifton will discuss all types of instruments and stress particularly how proper instrumentation can improve plating results.

The meeting will feature an exhibit of instruments. The manufacturers of instruments have been invited to display their products in a room adjacent to the meeting room so that those interested can examine and discuss with factory representatives the instruments described in the meeting.

Another speaker will be a top ranking member of the armed forces. His name and subject have not been determined.

The dinner will begin at 7:00 P.M. The arrangements for dinner and entertainment are under the direction of *Bob Redmond*, of Automotive Rubber. There will be attractive favors for the ladies as in former years, although this meeting is shaping up as the best ever.

Los Angeles Branch

With *Dr. A. K. Graham*, executive secretary of the Supreme Society, scheduled to be the guest of honor at the next monthly meeting, the Los Angeles Branch of the American Electroplaters' Society devoted a considerable portion of the time at its October 12th meeting to matters of national import which may warrant discussion with the supreme secretary during his Pacific Coast visit.

Dr. Graham is scheduled to appear before Los Angeles AES Branch on the night of November 9th, and before San Francisco Branch on November 10th. It was announced that he will deliver a talk at Los Angeles on "Copper and Zinc Alloy Plating."

Los Angeles Branch delegates to the Milwaukee convention reported that while the convention, as a whole, was

excellently conducted and planned, they somewhat deplored the fact that so little time was allotted to questions from the floor after reading of technical papers. Consensus of opinion was that fewer papers, with more liberal time allowed for questions, was preferable to the present practice of eliminating, or reducing floor discussion, because of program time schedules.

Among the more practical suggestions was one by *Ernest Lamoureux* who recommended that, in future national conventions, 10 to 15 minutes be set aside for open forum discussion and questions on each paper presented. Should there be insufficient questions to consume the allotted question period, Mr. Lamoureux suggested that the time should be switched to some other paper on which, perhaps, more lively discussion might ensue.

This suggestion is to be called to the attention of Dr. Graham in the hope that it might be found practical for use at the 1950 convention in Boston, or the 1951 gathering in Los Angeles.

Upon motion of *Marcus Rynkofs*, seconded by Earl Coffin, the branch voted unanimously to support the candidacy of *Don M. Bedwell* at the 1950 convention in Boston for the office of third vice president. Mr. Bedwell is now serving as general chairman of Los Angeles Branch's 1951 convention committee.

Ed Wells, reporting for Committee Chairman Harold Kroesche, announced that arrangements have been completed whereby Los Angeles AES Branch will conduct a demonstration of electroplating over television. The demonstration will be given over Station KTLA, Los Angeles, at 9:30 p.m., January 7, as part of the program "Science Page of the Week." This is a 30-minute program sponsored by the American Chemical Society which on the night of January 7 has agreed to allocate half of the 30-minute period to the AES Branch.

The educational program on October 12 was headed by *Donald Vance*, chief chemist of *Kelite Products, Inc.*, who spoke on "Metal Cleaning." Mr. Vance gave quite a complete coverage of that broad subject. He emphasized that cleaning procedures differ considerably for plating, enameling, painting, annealing, anodizing, etc., because all do not require the same degree of cleanliness. Electroplating, he said, possibly requires the highest degree of cleanliness.

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Inventories Simplified! One grade grips all grains—300 to 20. No special sizes needed!

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Goodbye to S. O.! There's no Stockyards Odor in Gripmaster. It's clean, odor-free!

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Best Finishers"



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In categorical order he discussed how types of impurities affect cleaning methods and the kind of cleaning compound required; solvent degreasing, vapor degreasing, hydro-carbon solvents, alkaline cleaners. He also touched upon the pH of cleaning solutions and how to buffer solutions to maintain pH.

AMERICAN SOCIETY FOR TESTING MATERIALS



Meetings in Pittsburgh and
Atlantic City in 1950

The American Society for Testing

Materials will hold national meetings in Pittsburgh and Atlantic City in 1950. The Committee Week and Spring Meeting will be held in Pittsburgh, and the 53rd Annual Meeting will be in Atlantic City, in conjunction with which is to be held the Ninth Exhibit of Testing Apparatus and Related Equipment.

The dates are as follows:

1950 A.S.T.M. Committee Week and Spring Meeting Hotel William Penn, Pittsburgh, Pa. February 27-March 3, inclusive.

1950 A.S.T.M. 53rd Annual Meeting: Ninth Exhibit of Testing Apparatus and Related Equipment Chalfonte-Haddon Hall, Atlantic City, N. J. June 26-30, inclusive.

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TYGON PAINT is made from chemically inert plastics dissolved in a solvent vehicle. It is applied by spray gun or brush . . . air dries quickly to form a tough, durable, tight-adhering protective plastic film. A Tygon Paint film will not oxidize, will not flake-off, craze or alligator. It will not support combustion.

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Write for your free copy of Bulletin 709 and learn how Tygon Paint can help cut your maintenance costs. Address Plastics & Synthetics Division, The U. S. Stoneware Co., Akron 9, Ohio.



Manufacturers' Literature

Barrel Tumbling Manual

Frederick Gumm Chemical Co., Inc., Dept. MF, 538 Forest St., Kearny, N. J.

A Barrel Tumbling Manual for bulk finishing of small parts has just been released by the above firm, manufacturers of barrel finishing supplies, etc., and industrial finishing chemicals. This is claimed to be the first comprehensive manual on barrel finishing ever offered to the trade. It includes: basic information on barrel finishing with numerous practical instructions

and suggestions; specific data on deburring with metallic and non-metallic media; and self-rolling parts. There is also considerable information on burnishing and the preparation of work for burnishing, care of burnishing medium, etc. In addition it contains information on calculation of barrel sizes, void space volume, etc. This book is available without charge upon application to the above company.

Cleaners for All Metals

Enthone, Inc., Dept. MF, 442 Elm St., New Haven, Conn.

This firm has recently issued bulletins describing their line of metal cleaners, as follows:

ZINC CLEANER 20

An anodic electrocleaner for degreasing zinc base die castings prior to plating with copper or nickel.

ALUMINUM CLEANER "E"

An etching type alkaline cleaner for aluminum. The cleaner is used for producing a fine etched finish on aluminum as well as to prepare it for painting and electroplating.

ALUMINUM CLEANER "NE"

A non-etching type aluminum cleaner to degrease aluminum without attack prior to organic finishing or electroplating.

CLEANER 100

An alkaline, anodic electrocleaner for steel.

BRASS CLEANER

Alkaline cleaner for degreasing of non-ferrous metals including copper, brass, tin alloys and lead alloys.

Copies of the bulletins are available on request to the above address.

Corrosive Handling Process Equipment

The Duriron Co., Inc., Dept. MF, Dayton 1, O.

A new 12 page catalog condenses the data published in 54 separate bulletins on corrosive resisting equipment and alloys, for handy yet complete reference for the operating, maintenance, consulting, plant, chemical and corrosion engineer. It covers corrosion resistant alloys such as Duriron, Durimet 20, Durichlor, D-10, Chlorimet 3 and Chlorimet 2—with composition, physical, mechanical and special characteristics and general corrosion resistance. It also covers Durco Corrosion Resisting Equipment such as Anodes, Bar, Ejectors, Fans, Heaters, Heat Exchangers, Steam Jets, Pipe and Fittings, Pumps, Kettles, Nozzles, S-bend Condensers, Sinks, Tanks, Tank Outlets, Tower Sections and 16 different types of Valves.

While brief, the data on each item is so complete that features, capacities and sizes, available alloys are given on all of them.

Abrasive Belt Polishing Machines

Production Machine Co., Dept. MF, Greenfield, Mass.

This firm has just issued a booklet describing their line of machines for

economical finishing of metallic surfaces by means of abrasive belts, as well as giving a history of the development and background of the firm. Included in their line are centerless polishers and grinders of all types, as well as wet surfacing machines. A feature of this firm's service to the field is their finishing laboratory, where actual production finishing problems are worked out without obligation to those taking advantage of the service.

Strippable Coatings

Better Finishes and Coatings, Dept. MF, 268 Doremus Ave., Newark, N. J.

This firm has just issued a booklet describing "How Canadair Uses Liquid Envelope."

This 24 page 8½" x 11" book is essentially a picture record of the many metal fabricating and assembly operations in the Canadair plant where a peelable, protective plastic coating cuts scrap losses and improves product quality.

Copies of the booklet are available on request to the above address.

Protection Fume Exhaust Ducts

Ceilcote Co., Dept. MF, Rockefeller Bldg., Cleveland 13, O.

A recent publication by the above firm describes fume duct production by means of chemical-proof sprayed linings. Copies are available on request to the above address.

Plating Equipment and Supply Prices

Hanson-Van Winkle-Munning Co., Dept. MF, Matawan, N. J.

The latest issue of the *Plating and Polishing News*, published by this firm, lists the prices as well as the descriptions of many of this firm's products. Future issues will also include prices, which is expected to expedite the placing of orders by eliminating needless correspondence. While such published prices are subject to change without notice, it is expected that they will be reasonably stable to be useful to potential customers.

Polishing Aluminum

Reynolds Metals Co., Dept. MF, Louisville, Ky.

The latest issue of the Reynolds Metals Technical Advisor is devoted to the polishing and buffing of aluminum. It includes recommendations

SPECIAL OR STANDARD

MAGNUS CAN PROVIDE THE CLEANING MACHINE BEST SUITED TO YOUR OPERATIONS

Your cleaning job may best be carried out on the flexible, speedy turnover basis of the standard batch-type Magnus Aja-Dip Machine, with or without accessory Magnus Hot Dip, Soak or Rinse Tanks and Dryers.

It may call for fitting your cleaning operation into the production line, with specially designed Magnus Machines.

Magnus plays no favorites. We can supply the machine best suited to your particular operations.

STANDARD

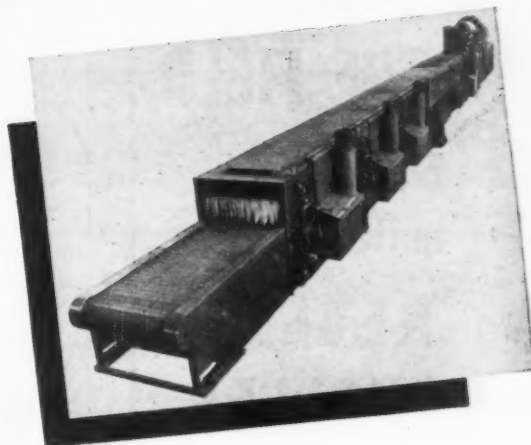


This installation is based on the #5 Magnus Aja-Dip Cleaning Machine, four Magnus #5 Hot Dip Tanks and one #3 Magnus Dryer.

It does 10 times the work of a former vapor degreasing installation at less than half the cost in removing oil and drawing compounds from a wide range of steel parts prior to heat treating and/or enamelling.

SPECIAL

This eight-stage special Magnus Cleaning Machine is used for cleaning steel parts prior to vitreous enamelling. The eight stages include alkaline washing, rinsing, acid pickling and hot air drying.



The right Magnus Cleaning Machine for your operation will cut plenty of time, labor, cleaner cost and rejects from your over-all costs.

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for wheel and belt polishing practices. Free copies are available on request.

Steel Blasting Shot

American Wheelabrator & Equipment Corp., Dept. MF, 721 Byrkit St., Mishawaka, Ind.

Bulletin No. 59 just issued by the above firm describes the advantages of their Tru-Steel shot for blast cleaning. This Tru-Steel shot is made of heat treated steel, not cast iron as formerly used in the industry. Advantages claimed for this new material are:

- 1.—Cleans as fast as chilled iron shot.
- 2.—Less wear on blasting equipment.
- 3.—Longer useful life of the shot.
- 4.—Lower cleaning costs.

Copies of the booklet are available by writing to the above address.

New Water Conditioning Bulletin

Elgin Softener Corp., Dept. MF, Elgin, Ill.

A 20 page bulletin No. 610 entitled "Elgin Water Conditioning" has been issued by this firm. This illustrated bulletin gives the water conditioning story—tells where it may be used profitably and why.

Complete up-to-date information on the design and application of water conditioning equipment covers zeolite water softeners, water treating chemicals, water conditioning systems

for boilers and processing, water softener modernization, zeolites, water filters, taste and odor removers and aerators. An improved water softener which delivers up to 44% more soft water per regeneration and which eliminates the loss of zeolite mineral is described in detail.

Rust Preventive Booklet

E. F. Houghton & Co., Dept. MF, 303 W. Lehigh Ave., Philadelphia 33, Pa.

In connection with the revision of its rust preventive line-up for industrial purposes, this firm, manufacturers of such protective products since introducing Cosmoline in 1869, has published a new booklet on rust preventives.

Entitled "A New All-Star Line-Up of Rust Preventives," this 8-page booklet thoroughly describes and lists the many uses for each of the eleven Rust Veto products developed by Houghton and proved through years of use in industrial applications. A full page chart outlines the physical properties of each Rust Veto and also lists such information as thickness and type of film, amount of coverage obtained in use and other pertinent data.

Photographic evidence is shown of pieces subjected to severe testing. Various types of testing equipment are also illustrated. For a free copy of this descriptive booklet write to the above address.



Complete Engineering Service for your Plating and Polishing Room

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New Bulletin on High Silicon Iron Plug Valves

The Duriron Co., Inc., Dept. MF, Dayton 1, O.

The Durco high silicon iron lubricated plug valve, now known as Type D, is described in a new bulletin. This valve in its basic design has been produced since 1921 and in many severe corrosive conditions it has given 20 years or more service without the use of spare parts. Changes and improvements now available in this valve are:

1. New type lubricator, permitting loading with stick or bulk lubricant.
2. Composite plug (optional) consisting of Duriron or Durichlor plug and stainless steel shank. It is almost impossible to break off this shank in ordinary service.
3. Teflon diaphragm at the bottom of the stuffing box which provides an anti-friction corrosion proof seal. Packing gland can be tight and still permit easy turning of the plug.
5. Packing glands are now made in Durimet 20, a highly alloyed corrosion resisting stainless steel, as standard.

Further information may be had by writing and asking for Bulletin 640.

News from California


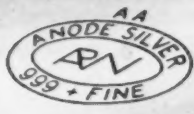

L'Hommedieu Enlarges California Branch

The Chas. F. L'Hommedieu & Sons Co., manufacturers of plating and polishing supplies, have doubled the capacity and storage space of their Los Angeles branch at 6052 Ferguson Drive. An additional building has been added to their facilities to better enable them to maintain a stock of their products for immediate delivery to firms in that area.

The firm has also added Mr. C. R. Johnson to the Sales Dept. of their Chicago office.

Hughes Aircraft Co., Culver City, Calif., has completed a major expansion of its metal finishing, painting and heat treating facilities, Allan Sulzinger, plating superintendent, reports.

The plating department has been moved into a new 40 x 100 foot process building in which heat treating,



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SILVER ANODES

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Users say our "AA" anodes produce a larger amount of finished work due to:

- ① The large reduction in the amount of rejects of finished goods. Less stripping.
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- ④ Cleaner, brighter finished work.

IMPORTANT

Every anode lot is laboratory tested and guaranteed to give complete satisfaction under normal conditions.

WE RECOMMEND APW SILVER CYANIDE
100 and 1000 ounce drums.

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CLEAN-RITE ALL PURPOSE CLEANERS
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Let us help you solve your Finishing Problems.
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Take advantage of our Practical Experience.

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plating, anodizing, painting and allied processing operations have been concentrated. New metal finishing facilities which have been installed for work on radar equipment, armament and helicopter parts include a 60-gallon gold solution tank, two 60-gallon silver tanks, one 150-gallon nickel tank and a stainless steel passivating and etching tank. Tank equipment for etching aluminum is also included in the new equipment recently installed.

Schlage Lock Co., 2201 Bayshore Drive, San Francisco, has completed installation on a new \$65,000 full automatic plating machine for work on door locks and parts. *Shepard & Kent, Inc.*, Los Angeles, West Coast distributors for *Lasalco, Inc.*, of St. Louis, did the installing and also report installation of a full automatic for plating plumbers' brass in chrome, nickel and copper in the plant of *Repcall Brass Co.*, Los Angeles. A full-automatic has also been set up for *Chief Products Co.*, Los Angeles, manufacturers of kitchen utensils.

John D. Millhorn, formerly a sales

engineer for the firm, has been promoted to manager of the metal finishing department of the *Mefford Chemical Co.*, Los Angeles. *M. Lukas*, formerly with *Master Buff Co.*, Van Nuys, Calif., has been added to the plating supply sales staff.

The Mefford Co. also reports completion of a new plating testing laboratory at its Los Angeles headquarters, 1026 Santa Fe Ave. *Richard Eaton* has been named laboratory head. By means of the newly equipped facilities, Millhorn reports, Mefford Chemical Co. is prepared to offer free chemical research and solution testing service to the Southern California plating industry.

Fourteen technical societies composed of local groups and chapters or branches of nation-wide organizations now hold membership in the recently organized Technical Societies Council of Southern California. Purpose of the organization is to co-ordinate the work of the individual units for more effective collective effort in dealing with local problems. The organization expects to occupy quarters in the Los

Angeles Chamber of Commerce building in the near future.

Harold Shepard and *George Kent*, who recently established themselves in Los Angeles under the firm name of *Shepard & Kent, Inc.*, to serve as LaSalco distributors, have announced opening of a testing laboratory for solution analysis as part of their facilities at 3132 E. Washington Blvd. *James Stewart*, formerly with the *Flintcote Co.*, has been appointed laboratory chief.

Mutual Enameling and Rust Proofing Co. has moved into a modern new plant at 2700 East 12th St., Los Angeles. The new plant has been laid out for high speed finishing at large productive volume. One of the several bake ovens installed is reported to be the largest in California.

Cal Products Co., producers of industrial cleaning compounds, soaps and detergents, have moved into a new and larger plant at 2132 Sacramento St., Los Angeles.



"PINT-SIZED" FILTER for "PINT-SIZED" TANKS!

IT'S NEW! IT'S DIFFERENT!

LOW IN PRICE

FILTERS ALL PLATING SOLUTIONS

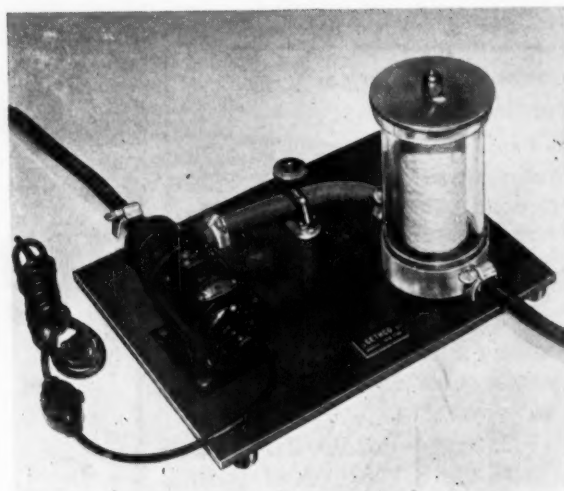
EASY AND ECONOMICAL TO OPERATE

ELEMENT CLEANED BY BACKWASHING

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Development of the Year!—The most recent addition to the SETHCO FILTER LINE—is the smallest filter unit on the market and sells for less than one half the price of SETHCO'S other high quality, low priced units.

Throw away your funnels and filter paper!—Now you can clarify your small batches as efficiently and as quickly as your large tanks.



Lucite Filter

MODEL LSU-5 Stainless (316) Pump
(CAPACITY—50 GAL/H)

Write for descriptive literature. Other Models Available.
Mention Your Specific Needs.

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A LETTER TO THE LADIES

TO THE LADIES
WHO ATTENDED THE
AUNT ELLA LUNCHEON
AT THE MILWAUKEE A.E.S. CONVEN-
TION
TUESDAY, JUNE 28th, 1949

Dear Ladies:

We hang our heads in shame, but are forced to inform you that the tickets which you filled out with your names and home addresses at the above luncheon have been lost. For the past four months, we have tried desperately to locate them—without success.

If you were one of the ladies who attended the above luncheon and filled out a card please write to me, and we will be very happy to keep our promise to send you a supply of household *Oakite*, together with one of our Silver Cleaning Plates.

Your husbands will testify to the fact that *Oakite Products* has built up a fine reputation in the metal finishing industry because of its ability to always keep promises, and we would appreciate your help in allowing us to maintain our record unblemished. Please print your name and address legibly. Thank you.

D. X. Clarin, Div. Mgr.
Oakite Products, Inc.
22 Thames St.
New York 6, N. Y.

OBITUARY

HERBERT H. WILLIAMS

It is with deepest regret that we announce the passing of Mr. Herbert H. Williams, of St. Louis, Mo. Mr. Williams was well known in the plating industry, having served as President of the A.E.S., as Editor of the Monthly Review of the AES, and as National Secretary of the supreme society.

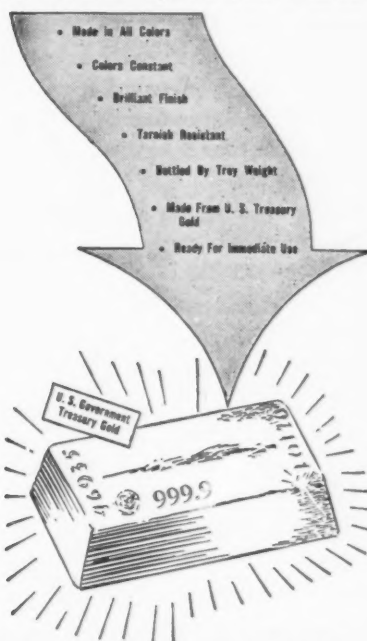
He had been with the American Stove Co. for fifty years, having been transferred to the factory at St. Louis from the Cleveland division. He had retired from his position as plating and polishing superintendent about five years ago. He is survived by his wife and three daughters.

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DAVIS-K—makers of GOLD PLATING SOLUTIONS—prepared in all colors that produce hard, tarnish-resistant, color constant deposits. Compounded from U. S. Treasury GOLD and highest (C.P.) chemicals. Sold by troy weight—certified 100% gold content. Solutions are simple to operate and maintain.

We are fully equipped to reclaim your old gold, rhodium and silver solutions. Also wires or racks that have been used for precious metal plating.

We welcome inquiries pertaining to precious metal plating problems. Distributors of Bakers' lustrous RHODIUM SOLUTIONS, that produce a long-lasting white finish.

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Get Metal Parts CLEANER!! FASTER!! CHEAPER!!

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CHEMCO'S EMULSION CLEANERS

- Embodies a New Principle of Detergency Causing the Soil to be Only Partially Emulsified in the Cleaning Solution. It Then Floats Out on the Surface of the Cleaning Solution Rather Than Remain in the Machine to Redeposit on the Work.
- Newer Emulsion Cleaners Designed to Reduce Material Usage and Produce Better Results.
- Longer Using Life, and Greatly Reduced Concentrations Afford Users a Definite Savings.
- A Blend of Synthetic, Surface Active Chemicals That Are Non-Corrosive, Completely Neutral and Fast Acting.
- Prevents Rust For a Number of Weeks.

Samples and further information supplied on request.

CHEMCO PRODUCTS COMPANY, Inc.

7740 West 47th Street

Lyons, Illinois

THE FATIGUE LIMIT OF CHROME PLATED AIRCRAFT STEELS

(Concluded from page 61)

tubes of annealed steel were chromium-plated and subsequently heated to different temperatures. "Tongues"—strips about 3/16-inch wide and two inches long, with one end left attached—were then cut in the tubing (Fig. 3) to permit a qualitative evaluation of stresses in the chromium plate.

Tongues cut in plated tubing that had not been heated were found to bend slightly outward from the surface of the tube, indicating the presence of residual tensile stresses in the plated layer. Baking the plated tubes at temperatures around 200°C. was found to increase further the tensile stresses in the chromium, as shown by the greater bending of the tongue away from the tube surface.

From these observations, it was concluded that the decreased fatigue limit accompanying the heating at 200°C. of the plated fatigue-test specimens was due to increased tensile stresses induced in the chromium plate. This conclusion has been further substantiated by experiments showing that electrodeposited chromium subjected to a heating-and-cooling cycle increases in density and thereby contracts; since no significant dimensional changes occur in the steel upon completion of the cycle, the steel tends to restrain the

complete shrinkage of the chromium layer and thereby increases the tensile stresses in it. If the chromium-plated steel is heated to a sufficiently high temperature (above 400°C.), the contractive forces in the chromium produce sufficient tensile stresses to cause plastic flow or rupture of the chromium plate, thus relieving the residual tensile stresses in it. Thus, when "tongued" tubes (Fig. 3) were heated above 400°C., the free ends of the tongues were depressed below the surfaces of the tubes, indicating a release of the restraint in the steel initially caused by residual tensile stresses in the chromium. This suggests that the increased fatigue limits produced in the fatigue specimens heated above 400°C. were caused by stress relief in the chromium plate accompanying its plastic flow or rupture.

1. The maximum stress a part will withstand without failure for a specified large number of repeated or cyclic stresses.
2. For further details see, *The effect of chromium plating on the endurance limit of steels used in aircraft*, by Hugh L. Logan, J. Research NBS, 43, 101 (1949) RP2011.

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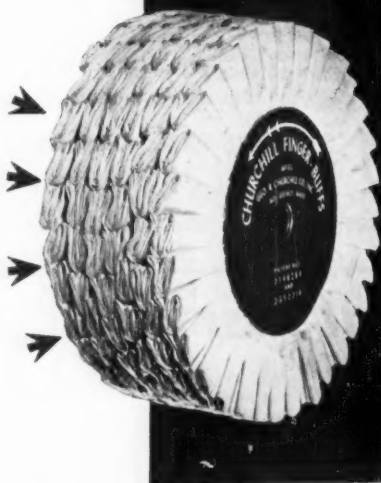
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dent left with an un-answered "why?"

The last lesson, which gives helpful advice to those who are entering the electroplating industry, either as a plater or as a shop owner, is a model in frankness and "straight from the shoulder" facts for the un-informed, and any prospective shop operator would do well to consult this material before making the usual avoidable errors that may cost much time and expense.

W. A. R.

Letters to the Editor

Japanese Plater Desires American Correspondents

Dear Editor:

You may be surprised to receive this letter so I'll first introduce myself to you. I am 21 years old and employed by the Naigai Bicycle Industry Co., Ltd., which is located in Adachi, about 10 miles from the center of Tokyo.

I am now working in the electroplating shop here and am studying electro-

plating in this company. In Japan there are few scholars who are investigating electroplating and polishing, and manufacturers are dependent on old techniques. I am now studying high speed nickel plating and am looking forward to this new experience with much joy and high hopes.

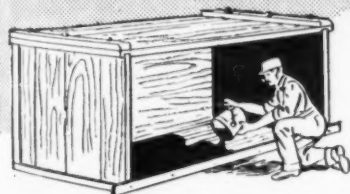
I go to the library whenever I can and every holiday I am in the C.I.E. Laboratory in order to read your magazine, METAL FINISHING, which gives us many suggestions, but is a little technical for me to read. I hope I shall be able to read it better next year.

One of my ambitions is to correspond with a few Americans who are working in metal finishing. It occurred to me that you might be able and willing to introduce me to some young electroplaters in your country. I would certainly appreciate this and also any letters from platers who are interested in corresponding with me.

Very sincerely yours,

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RECTIFIER CIRCUITS AND POWER COSTS

Dear Editor:

I should like to offer the following comments concerning the mode of operation of the 3 phase bridge rectifier relative to the article "Rectifier Circuits and Power Costs," which appeared in the June 1949 issue of METAL FINISHING. The last paragraph of the section entitled "The Bridge Circuit" on page 97 reads as follows:

"The point to remember here is that the current always flows through a series network consisting of one rectifier arm plus two more arms which may be considered as being in parallel."

This statement is rather misleading since this condition holds only during very brief commutating periods. I suggest something along these lines:

"The point to remember here is that the current usually flows through a series circuit consisting of two rectifier arms."

The figure herewith illustrates current flow at different times for a phase

rotation of top-center, center-bottom and top-bottom. Condition (A) is that instant of time when the top-center phase is at a positive maximum. Since the current flow must take place between the two AC lines which have the greatest difference of potential at that instant, then at this time the top right element of the bridge carries the current to the load and the center left element returns it to the transformer. If the current were returned to the transformer by two elements in parallel, which is what Mr. Reinken implies in his article, then we would have a *difference of potential across a point*, because we are assuming an ideal rectifier with zero forward drop. A further study of this condition brings out the fact that the remaining four elements are blocking. Thirty electrical degrees later, the difference of potential of the top-center and top-bottom phases are equal, and conduction ceases in the center left element and the bottom left element takes over. In an actual rectifier, this transfer cannot occur in zero time because there is leakage reactance in the circuit. This

reactance is very small in a metallic rectifier for electroplating, however, and therefore the commutating time is extremely small relative to the 120 deg. conduction period of each element. Condition (B) is 60 degrees after (A), when the top-bottom phase is a negative maximum. (C) is 60 degrees after (B), when the center-bottom phase is a positive maximum. (D) is 60 degrees after (C), when the top-center phase is a negative maximum.

There are a number of references in the rectifier literature which treat of the operation of the 3 phase bridge. One that comes readily to mind is E. A. Richards' article in the *Journal of the Institution of Electrical Engineers* in December 1941. I quote the first part of the last sentence of Section (3.1):

"It should be noted that at any instant there are always two arms of the rectifier operating in series."

Very truly yours,

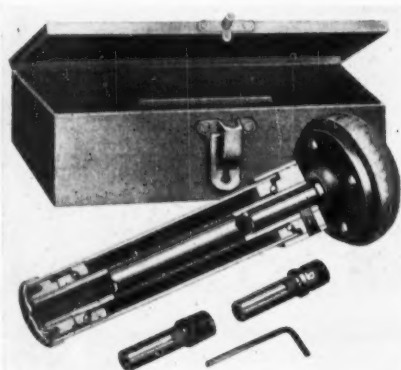
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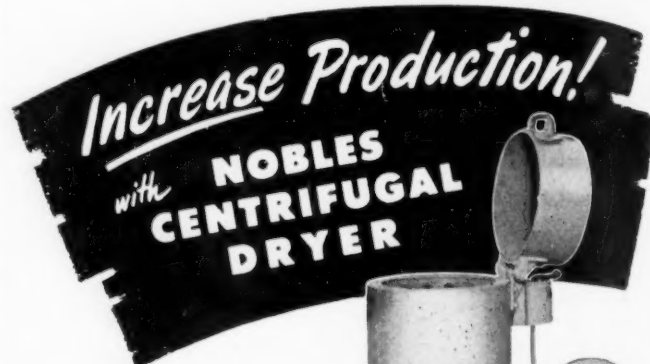
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MR. REINKEN'S REPLY TO MR. BUCKLEY'S LETTER

Dear Editor:

Mr. J. J. Buckley's letter and sketches will be of value to those readers who are interested in rectifier theory and have not previously encountered the classical treatment of the three-phase bridge circuit.

It should be noted that Mr. Buckley stipulates "an ideal rectifier with zero forward drop . . ." that is, a theoretical rectifier having zero resistance in the forward direction. Mr. E. A. Richards (whom I had the pleasure of knowing personally for some years and for whose ability I have the highest regard) is careful to make the same qualification in the 1941 paper referred to by Mr. Buckley. In the final paragraph of Section 3.1, which deals with the bridge circuit, Mr. Richards says— ". . . assuming no voltage drop in the rectifier."

The circuit analysis briefly outlined by Mr. Buckley was developed many years ago as a useful first approximation for mercury-arc rectifiers. The

conclusion that practically instantaneous commutation occurs is valid only for (theoretical) rectifiers of zero forward resistance or, with appropriate displacement of the commutation point, for rectifiers of the mercury-arc type which have a forward voltage drop which is substantially constant and is independent of current flow.

If the "ideal" rectifier elements in Mr. Buckley's circuit sketches are each replaced by a rectifier element in series with forward resistance the analysis will produce quite different results. We now have a forward voltage drop which varies (although not linearly), with current flow so that the "difference of potential across a point" mentioned by Mr. Buckley, is replaced by "difference of potential across a rectifier element with forward resistance." The application of *Kirschhoff's* laws to this new circuit (which much more nearly represents real rectifiers) will show that currents must flow simultaneously in the parallel arms. Of course, the two currents will be equal only when the two instantaneous voltages are equal, and for all other poten-

tials the currents will be unequal and will depend not only upon the values of the instantaneous potential but also upon the instantaneous resistances of the rectifier elements. Because the forward resistance increases with decreasing current flow the difference between the currents in the two arms will increase very rapidly on either side of the equal-current point.

However, the known characteristics of metal rectifiers do not support any circuit analysis which implies a discontinuity in operation or an instantaneous transition of any nature. An electronics engineer would arrive at this conclusion (without detailed mathematical analysis) knowing that a square wave front output cannot be produced from sinusoidal inputs by the use of only simple circuit elements with continuous characteristics.

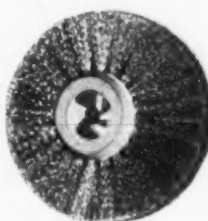
In justice to Mr. Buckley it should be conceded that the wave shape implicitly described by his analysis closely approximates the wave shape of real rectifiers as observed on cathode ray oscilloscopes. The difference is one of degree and can be accounted for by

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the difference between the actual resistance and zero resistance. However, there is real danger in the "zero forward resistance" postulate and, if used indiscriminately, can lead to conclusions which do not correspond, even approximately, to the actual performance of real rectifiers. For example,

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the use of this postulate in analyzing the operation of two rectifier units connected in parallel to the same plating tank would apparently show that such operation is not practical, whereas, as we all know, such operation is standard procedure in thousands of plating plants.

A complete demonstration of the general case of two parallel arms, the specific case of the wye circuit (which Mr. Buckley ignored), and the bridge circuit, would require perhaps five or six pages and would hardly be justified in METAL FINISHING. I am sure, however, that if Mr. Buckley modifies his sketches and analysis to include the element of forward resistance he and I will be in complete agreement.

I might mention that the major conclusion of my brief article in the June issue (that the choice of rectifier circuit must take into account the charac-

teristics of the rectifier elements) is in no way affected by the present academic discussion.

Very truly yours,

L. W. REINKEN

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